The Foundry Trade Journal
AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 19. NOVEMBER, 1917. No. 191.

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "Journal" within the reach of working Moulders and Pattern-makers, the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
165, Strand, London, W.C.

OWING TO THE REDUCTIONS IMPOSED BY THE GOVERNMENT ON PAPER SUPPLIES, THE PROPRIETORS ARE COMPELLED TO PUBLISH "THE FOUNDRY TRADE JOURNAL" ON A THIN PAPER DURING THE CONTINUANCE OF THE RESTRICTIONS.

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—

General Secretary: E. A. Pilkington, 1, Clarence Villa, St. Catherines, Lincoln.
Manchester: J. Hogg, James Street, Radcliffe, Manchester.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Sheffield and District: J. Dickinson, 157, Abbeyfield Road, Pitsmoor, Sheffield.
Scottish: J. Macfarlane, 3, Sharrocks Street, Ibrox, Glasgow.
London: Jas. Gaunt, 11, Sedgemore Avenue, East Finchley, N.
Halifax: J. C. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.

Contents.

	PAGE
Notes and Comments	573
Petroleum Oils	574
The Pattern for a Large Condenser Waterway	575
Committee for Scientific Industrial Research	577
Moulding Fly Wheels.—II.	580
Sands Used for Metallurgical Practice	583
Cast Iron: Past, Present and Future	584
Industrial Reconstruction	585
New Experiments on Shock Tests and on the Determination of Resilience	586
British Foundrymen's Association:	
Scottish Branch	589
Newcastle Branch	589
London Branch	589
Raw Materials after the War	589
Refractories	590
The Use of Metric Iron by Primitive Man	593
Finishing Patterns	598
Repairing Open-Hearth Furnaces Whilst in Work	599
American Foundrymen's Association: Annual Meeting	600
Open-Hearth Furnace Dimensions	601
New England as a Foundry Centre	602
British Foundrymen's Association	603
Trade Talk	605
Personal	608
Applications for Patents	608
New Companies	610
Deaths	612
Monthly Price List	614

Forthcoming Events.

NOVEMBER 24.

British Foundrymen's Association (Newcastle Branch).—Open discussions.

NOVEMBER 17.

British Foundrymen's Association (Scottish Branch).—"Electric Cranes," by A. Weddell.

NOVEMBER 9.

British Foundrymen's Association (London Branch).—Lecture.

NOTES AND COMMENTS.

Use of Basic Iron.

In the course of a recent lecture Professor W. G. Fearnsides, reviewing the conditions of ore supply from overseas ironfields to British furnaces, noted that in them—as in the home ironfields—there is already a shortage of readily accessible non-phosphoric hematite, and that it is only in the more distant countries, where railways are being built to link up ore bodies with the ports, that there is any prospect of a considerable increase in the supply of pure hematite. Since the beginning of the present century the only countries which have made notable progress in steel production have increased their output by developing supplies of phosphoric ores, of which there is an ample, if not an inexhaustible, reserve.

"In the most recent year (1916), during which a British record for steel production has been established," said the lecturer, "the basic-steel output shows proportional increase, but the production of hematite pig-iron is responsible for over two-thirds of the total increase of pig-iron output on the previous year. In war-time the call for high-class steel of reliable quality is especially urgent, and so long as rich hematite ore can be bought, there is considerable saving of home labour, both at the mines and at the furnaces. In peace-time hardly more than one-fifth of the total British pig-iron output is needed for purposes which suitably refined basic iron could not be made to serve. Prior to the war, when shipping tonnage was abundant, almost exactly one-half of the British pig-iron was made from foreign ore. Does it not seem that, when labour again becomes available for mining or quarrying home ores, and for handling the greater bulk of lower-grade material at the furnaces, it will be sound policy for this country to adopt the basic process on such a scale that, even with expanding trade, it will become unnecessary to purchase from foreign countries so large a quantity of ore, for the carriage of which so great a proportion of our mercantile shipping tonnage has in the past been employed?"

"If for bulk production the change over from hematite to basic steel be effected," he continued, "the onset of the change must affect the blast-furnace industry in different districts of the country very unequally. Blast furnaces are generally located near the margin of the coalfields, and on the sides of the coalfields which are nearest to the iron-ore supply. To British coalfields adjoining the western coasts of England and Wales and of Scotland, ore from the northern ports of Spain has in the past come by sea more cheaply than an equivalent amount of ironstone could be supplied by rail from the Jurassic ironfields of the eastern counties of England. Orefields in Northern and Western France, where the ore is 'basic,' are nearer to these western British coalfields than are the Spanish ports, but unless

the shorter sea passage and facilities for quick loading outweigh the disadvantage of lower metal content of French as compared with Spanish ore, the available shipping tonnage will probably continue to be employed to greater economic advantage in carrying the richer ores from Spain, and perhaps also the hematite from the Mediterranean coasts. The blast furnaces near the western coalfields are therefore likely to continue to manufacture hematite iron from Spanish and Mediterranean ores."

Prof. Fearnsides further pointed out that to coalfields on the eastern flanks of the Pennines, more especially the coalfield of Northumberland and Durham adjoining the North-East coast, ores from the ironfields of Scandinavia and also those of Northern France, have a considerably shorter sea passage than from Spain, and in these districts it would seem that by economic conditions the smelting of basic iron from phosphoric ores will be encouraged to increase. Adjoining this North-East coalfield there is the rich Jurassic ironfield of Cleveland; and farther to the south, not far from the South-East Pennine (North Midland) coalfield of Yorkshire, Derbyshire, and Nottinghamshire are the wide orefields of Lincolnshire, Leicestershire and Oxfordshire, conveniently situated in proximity to this greatest of British home reserves of coal. It was in the Cleveland district that the basic process of steel-making had its first beginnings. Now, both in Cleveland and in the East Midlands farther to the south, the basic iron industry has taken root, and is growing rapidly; and, with the experience of the past to guide it, and unhampered by great distances, there is opportunity for development, which, in the course of a few years, might raise the British basic-steel output, if not to surpass the production of North America, at any rate to equal the pre-war production of Belgium, or perhaps that of the basin of the Saar. With five thousand million tons of ore ready for quarrying or mining within fifty miles of a region which holds at least fifty thousand million tons of the very best non-anthracite coal, there is no valid reason for the iron and steel industries of Eastern England to look forward except in confidence to the time when the price of overseas hematite will become prohibitive.

British Oil Possibilities.

Another important direction in which work is being carried on at the present time in addition to the development of our resources of basic iron ore is the production of oils from oil shales or colliery shales. With reference to oil shales, we are faced with several possible developments, one of which is the finding of oil shales sufficiently free from sulphur to be profitably worked in this country. Another is the active development of processes for the low-temperature distillation of coal, and a third is the utilisation of certain colliery shales which contain a comparatively high percentage of oil.

The Ministry of Munitions, as is generally known, created some time ago a Department to deal with this matter, and it has been a veritable storm centre now for some time. Let us take the case of the processes for the low-temperature distillation of coal. These have now been before the public for some ten years, and many investors look back with mixed feelings to the history, say, of the original Coalite Company. Since the Coalite fiasco, however, there have been many other processes brought forward, amongst them being the Delmonte, Tarless Fuels, Rollasons, and others too numerous to mention.

As to the ultimate value of any low-temperature distillation process, opinions widely differ. So far as we know, they have not proved very profitable in the past, and Mr. T. F. Winmill recently, as a result of very considerable research, expressed the opinion that low-temperature distillation cannot be made to pay on the value of the by-products themselves. Of course, it would be different if a large and profitable market could be obtained for the smokeless fuel which is the result, but so far it has never been possible to induce the British housewife to burn semi-cokes. On the other hand, Mr. H. Eustace Mitton holds the view that there is a prospect of inferior coals being successfully treated as a commercial proposition, providing the coal is used to destruction. Mr. Mitton asks for the brains of independent experts.

Now there should be sufficient independent experts in this country to consider the matter carefully and impartially. The importance of securing a home production of oil cannot be overrated, and it is, therefore, a matter of some satisfaction to learn from an official announcement that Mr. Walter Long is taking control of all questions affecting petroleum oils and petroleum products. Mr. Walter Long, in turn, has appointed Professor Cadman to take charge of the organisation which will be essential for giving effect to the instructions of Mr. Long, who will assume the title of "Director of the Petroleum Executive."

Petroleum Oils.

Mr. Walter Long, M.P., has been requested by the War Cabinet to take control of all questions affecting petroleum oils and petroleum products. Mr. Long has appointed Professor Cadman, C.M.G., Petroleum Adviser to the Colonial Office, and Professor of Mining of the University of Birmingham, to be his Technical Adviser and Liaison Officer between the various Government departments. Professor Cadman will also take charge of an organisation which will be established for giving effect to Mr. Long's instructions, and will assume the title of Director of the Petroleum Executive

Mr. E. S. Shrapnell-Smith, chairman of the Joint Committee of Mechanical Road Transport Associations, has been appointed Economy Officer to the Petroleum Executive, and he will be concerned in introducing economics both in his Majesty's Services and in the civil use of petroleum and petroleum products.

The headquarters of the Petroleum Executive are at 8, Northumberland Avenue, W.C.2, to which all communications should be addressed.

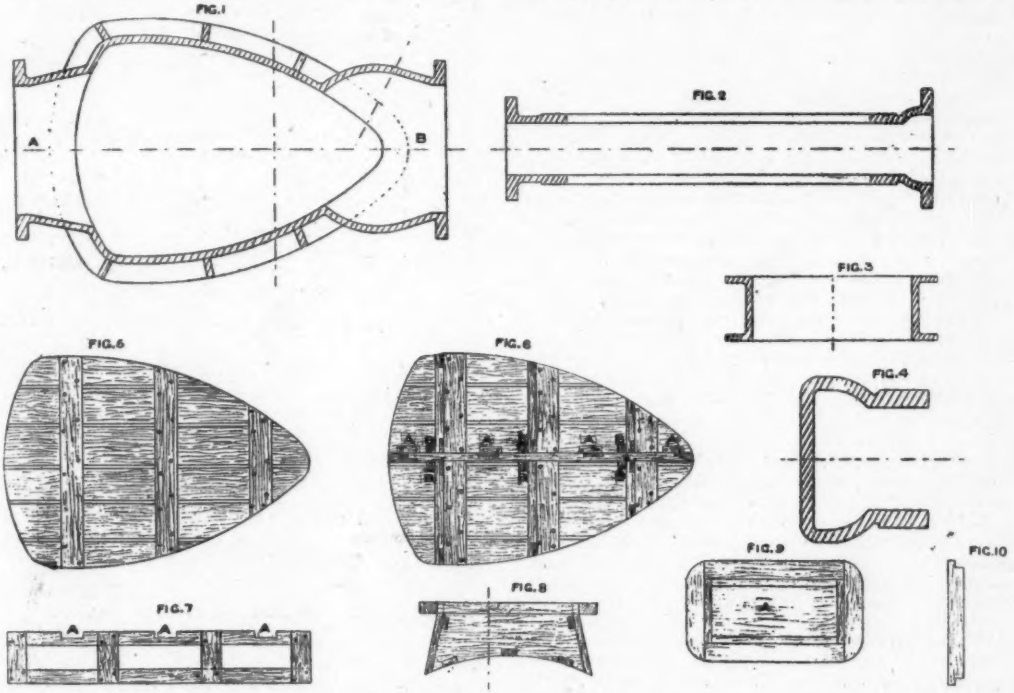
FERRO-CHROMIUM.—According to a contribution of Mr. Robert J. Anderson, in a recent number of the "Iron Trade Review," chromium in steel does not act as a scavenger, nor does it confer soundness on the steel as do silicon and aluminium. But added in small amounts it increases the tensile strength to some extent without markedly decreasing ductility. When added in excessive amounts it causes brittleness. The effect of chromium when added to steel is to raise the normal critical range, thus causing changes to take place at high temperatures and also more slowly. Hence, chromium steels are harder than ordinary steels, because quenching more effectively prevents the transformation of the austenite. When added to iron, chromium does not materially harden the metal. Chromium steels contain from 1 to 4 per cent. or more of chromium, and the carbon may range from 0.50 to 2 per cent.

The Pattern for a Large Condenser Waterway.

By James Edgar.

The type of condenser used in modern turbine work is similar to that shown in section in Figs. 1, 2 and 3. In first-class work they are invariably made in gun-metal, and the metal is seldom more than ½ in. thick. In very small waterways a block pattern and corebox make perhaps the simplest job, and sometimes if the metal is thick, and only one or two castings are wanted, a shell pattern will answer the purpose. A shell pattern for such a job, however, is very frail and the construction of a large corebox expensive. The other method open to the patternmaker is to build up a block pattern, must be drawn ⅛ in. less than the drawing sizes all round. Waterways are seldom set down in the pattern shop. It is sufficient to have a drawing of the branches. One of the finished plates is shown in Fig. 5. Even if they have not been finished together, they ought to be screwed together, and the centre lines squared over.

Frames are necessary to keep the plates the correct distance apart. They should be strong, as the accuracy of the finished pattern depends upon them. One frame, Fig. 7, is the entire length of the plates, and cut out at A to clear the battens.



and arrange for the core to be made inside the mould, by means of sand and wood thicknessing. The method of thicknessing a mould with timber is only applicable on a straight bottom or slides, but it is not done as often as it might be.

In making the pattern the main body ought to be built first, and the branches screwed on afterwards. Generally speaking, half-lapped frames are preferable to open-jointed plates, as they keep their shape better, but it is seldom possible to get timber sufficiently wide because of the curves to give a good joint. If the joints are kept ⅛ in. open the timber will swell freely, without warping the plates. The plates are bound by means of battens screwed on the back, and to these battens the distance frames are screwed. It is good practice to screw the plates together when sawing and finishing them, but if this is not done one should be finished first, and used as a templet for the other. As the lagging round the plates will be ½ in. thick, they

The cross frames are similar and ought to be made perfectly square. It will be seen in Fig. 6 that the centre frame is kept in position on the bottom plate by means of "buttons," or square blocks A, and the cross frames, besides being screwed to the battens on the bottom plates, are kept at right angles to it by means of corner blocks B. The body must be built either on level skids or on a level floor. When the frames have been screwed in position, a few strips may be screwed on the top plate to guide the frames into position, and before it is screwed down it will have to be squared carefully from the floor. Care in setting the frames will save endless trouble afterwards.

The work is now ready for lagging. The reason for the lagging being made so thin is that ½ in. timber will screw to the circle without shaping, the only shaped pieces necessary being at the three corners, because of the quick radii. The strength of the pattern does not depend on the lagging, but

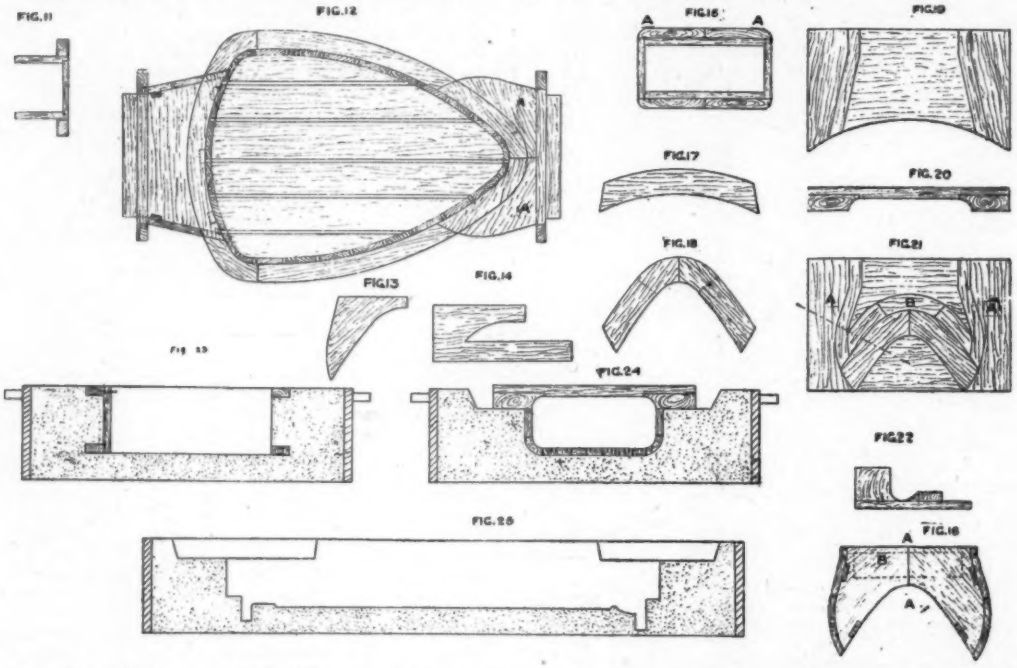
on the top and bottom plates and the frames. The lagging, like the frames, is better open jointed.

We can now leave the body and see to the branches. The flanges and ribs will not be screwed on until after the branches are in position, as the flanges at the ends are simply facings on top of the branches. Figs. 8, 9 and 10 illustrate the pattern for branch A in Fig. 1. It consists of top and bottom plates with stays like Fig. 10 to keep them the proper distance apart. The lagging is best screwed on the outside of the plates. If the plates are made to the outside there is danger of the end wood tearing the mould when drawing the pattern from the sand. The front plate A, Fig. 9, is best set in on a check cut on the top and bottom plates. It will be observed, by referring to Fig. 9, that the side flanges are kept the full distance, and the long flanges fitted between. This is the better way for moulding. Prints are not made for the body, but it is necessary to make them for the branches. The cores will have to be chapleted, but the prints should be about 3 ins. thick.

Branch B, in Fig. 1, is made in a similar way to the other branch with the irregularly-shaped pieces at top and bottom screwed on separately. A plan of the branch without these pieces is shown in Fig. 16. and an end view in Fig. 15. It is advisable that the plates be jointed along the line A-A, Fig. 16, otherwise the timber on the legs will be short grained. A thick batten B will hold them together. When the stays have been screwed in place the lagging will have to be made. It will be necessary to plane the concave and convex. Unlike the body the lagging is a support for the plates, and should be at least 1 in. thick. The shape on the top and bottom of the branch, unless it is a very large one, may be made in two pieces. A in Fig. 12, and Figs. 13 and 15 represent them. It is as well to cut them square from a templet, and shape them with templets like Fig. 14, working off the face.

The pattern can be quite finished now. As the branches are heavy, it is not a simple matter screwing them to the main body. Provision ought to have been made in the main body in the shape of thick blocks fitted between the top and bottom plates, to which the branches could be pocket screwed. It is advisable also to screw two edge battens the full length of the pattern, cutting back at one end, so that they will rest on the top of branch B. The flange has to be fitted against the branches and a facing screwed on the branches to continue it. The completed pattern is shown in Fig. 12.

In work of this kind the patternmaker has to be in attendance on the moulder practically all the time from when the job first goes into the sand until the mould is closed ready for casting. The job can be made in a two-part box, and it is necessary for the moulder to drop his joint at each end to the centre of the radius that is taken off the corners of the branches. This is best seen in Figs. 24 and 25. The writer has not thought it necessary to show the cope with the projecting pieces, as practically all the work is in the bottom. As the flanges round the body of the waterway are screwed from the outside it is necessary for the moulder to loosen them off as soon as he lowers the job on the prepared bed. When drawing the pattern from the sand both flanges are left in. The top flange must be left as the thickness pieces hang from it; the bottom flanges are left in to prevent dirt getting in while the core is being made. When the pattern has been drawn and the mould dried, the thicknessing may be done. Three or four inches is a good width for the strips, and they ought to be made a few inches longer than the depth of the mould, with an occasional one the exact depth, as a gauge for levelling off the top of the core. They are nailed into the top flange as shown in Fig. 23. It is not necessary to fasten them at the bottom.



They will hang all right from one sprig while the moulder is making his core. They ought to be pressed close together. It is apparent that the branch cores cannot be made so simply. It is not practicable to fit wood thicknessing on rounds. The moulder can be working at the branches while the patternmaker is nailing the thickness on the body. It is necessary to make two pieces of flange like Figs. 17 and 18. Because of the peculiar shape of that shown in Fig. 18, it is better to build it in two thicknesses. Those pieces are set into the recess formed by the facing on the bottom of the branch, and continue the core from the body to the branches. They do not require to be fixed in any way.

The method of making up the branch cores is illustrated in Fig. 24. The bottom and the fillets are sand thicknessed. The straight portion to the top of the mould is wood thicknessed. It is more trouble to thickness this part than it was the main core. Sprigs driven into the mould do not hold, and they spoil the face. The moulder must build his core as the pattern-maker puts in the pieces. It is quite possible to thickness right across the flanges to the print, but it is not a good method. It is much better to draw the branch flange from the mould and make new flange pieces the thickness of the metal extra in width. If this is done, when the core is finished the moulder can clean out the sand thickness from the mould and lift away the making-up flange, with less trouble and risk to the mould than if a sand thickness had been put on top of the original flange. The only way in which the top of the branch cores can be made is by means of a box. This is the most awkward part of the job. Great care has to be exercised in setting the box on top of the mould. When it is set weights will keep it firm while the moulder is filling up underneath it. It is better to cut a hole in the centre of the bottom of the box, which the moulder can use for ramming, although these holes are not shown in the sketch.

The core at the part where the hole is can easily be finished with a strickle. The construction of those branch boxes is shown in Figs. 19 to 22. That shown in Figs. 19 and 20 is made of a bottom and two pieces, to form the shape and from which the fillet is cut, screwed to it As these keep the bottom from warping battens are not necessary. Sharp edged, or, as they are more often called, feather-edged fillets, should always be avoided where possible, and in a box like this it is not much extra trouble to recess the bottom about ¼ in., into which the sides are fitted. There is more work in the other box, and it is not possible to avoid feather-edged fillets without causing a great deal more labour. It is necessary to refer to Fig. 4 for the shape of this box. After the outside pieces A, Fig. 21, have been finished and screwed on, care being taken to tack the fillet down, the flange can be put in.

It will be noticed that the box is not made to the shape of the branch on the inside, but is carried straight across. The main core, of course, can only be thicknessed up to the point where the branch opens into it. When the fillet pieces B, Fig. 21, are nailed in the box is finished. The fillets can easily be cut to templets.

Some might take exception to this method of making the branch cores, but in the writer's experience it has proved the best. If full boxes are made, the core, instead of being in one piece, is in three, and more chapleting is necessary, while there is not the same surety of a uniform thickness of metal. The only parts of the core which want watching are the tops which have been made from the boxes. There is a tendency for the boxes to rise, and it may be found necessary, after the top part is lowered for the purpose of testing the thickness, to rub them.

Committee for Scientific Industrial Research.

The new Research Department has now issued its Report for the second year—ended July 31, 1917. As was the case last year the bulk of the report (about 40 pages) renders an account of the activity of the Advisory Council, this portion being subdivided into two parts, in the first of which are described the steps the Council have been able to take during the past year to organise a systematic approach to the problem of industrial research, on a co-operative basis wherever this method of finance is practicable, and by the Department itself in those important fields of work which call for independent State action. The one question of policy to which throughout the year the Council have continuously devoted their attention, is the working out, with all care and advice they have been able to command, of the policy of co-operative industrial research foreshadowed in their last report. It does not seem likely that most of the new or previously existing associations will be qualified to avail themselves of the full benefits that the Government is prepared to offer. On the other hand there appears to be no difficulty in the establishment of associations, which would conform to the necessary conditions, in connection with, or independently of, existing corporations. Lord Crewe, who was at that time Lord President of the Privy Council, received a deputation of the Board of Scientific Societies on December 1 last, at which he outlined the policy of the Government in regard to industrial research. He announced their intention to ask Parliament to place a large fund—a million sterling—at the disposal of the Department to enable it to co-operate with the industries of the country in the foundation and maintenance of approved Associations for Research during the next five years or so. After these initial years it is expected that the larger industries, at any rate, will be able and willing to carry on the work of the Associations without assistance. The intention of the Government is to make a contribution to the assured income of such associations from the subscriptions of their members, varying in amount according to circumstances, and with a normal maximum of pound for pound, though in very exceptional cases this limit may be exceeded. Lord Crewe also announced that the Board of Inland Revenue would be prepared to instruct Surveyors of Taxes to allow as a working expense for income tax purposes the contributions by traders to industrial associations formed for the purpose of scientific research for the benefit of the various trades.

The Council has drafted a model Memorandum of Association for companies limited by guarantee of nominal amount and working without profit, such as would fulfil the purposes they had in view, and at the same time be registered by the Board of Trade under the Companies' Acts without the use of the word "Limited." They have also prepared notes for the guidance of those desiring to draft the articles of an Association for Research

and a short statement of the conditions under which the Department would make grants to such an association when founded. Further the Department has issued a brief descriptive leaflet on "The Government Scheme for Industrial Research," which explains in non-technical language the manner in which the associations are expected to work. These three documents are reprinted in Appendix III. of the Report.

As regards the constitution of the Governing Body or Council of an Association for Research, it is obvious that capital, management and science must have suitable representation. But the Council believe further that greater success and a wider scope of action will be attained, if provision is made also for the inclusion of labour. In most cases only skilled labour will be concerned.

It is intended that the Research Associations should include as many of the firms in each industry as possible, but the Council recognise with Lord Crewe that "where there is so great a variety of applications as in the engineering industry, it may be found advisable to form a series of distinct associations for research purposes." Substantial progress has already been made towards the establishment of a National Research Association by the great staple industry of cotton.

In some cases the industry may be prosperous and the leading firms possessed of what they believe to be valuable and exclusive information, which they fear might be endangered by co-operative research. The Council have remarked that those industries which call for the most complex organisation and are most in need of scientific guidance, if they are to meet modern conditions successfully, are for the most part those in which the smallest progress has been made towards research on a co-operative basis, as, e.g., in the chemical industries. There are, however, important fields for industrial research which the Council can never hope to cover by means of Research Associations. Research into fuel is one of these.

There is still another class of scientific problems of great importance to industry, not susceptible of treatment by Associations for Research, viz., the determination of constants and standards whether physical, chemical or bacteriological, and the accurate testing of manufactured products in the interests both of manufacturer and consumer. The range and importance of this work and of the research which it entails are certain to grow rapidly in the future. The experience of other countries goes to show that it is work which the State must itself undertake, or at least control, if it is to be adequately served. The Council welcome accordingly the arrangement recently made by the Committee of the Council with the Royal Society under which the Department will become financially responsible for the maintenance of the National Physical Laboratory.

There seems to be room in the industrial world for three methods of financing research. There is research which the individual firm finds it remunerative to undertake at its own expense. Secondly, there is research which is financed on a co-operative basis, and, lastly, there is research which must be financed by the State if it is to be done at all. Far-reaching scientific investigations which are likely to affect several sections of the industry are more suitable for co-operative than for single-handed attack. There will still be ample room for private research by individual firms on the lines of their own special work. Indeed, they may be expected to gather many suggestions for this from the results of the co-operative investigations.

The report then briefly describes the progress made in a number of sporadic investigations aided by the Department since its establishment, or initiated during the past year.

Surveys of the Fields for Research.—Besides the initiation and direct conduct of researches which from their nature are unsuitable for private enterprise and unlikely to be undertaken on a co-operative basis, the Council recognise that it will be a permanent and important part of their duties to arrange for surveys to be made of existing scientific knowledge and the fields for research in particular industries. Systematic surveys of this kind are needed in many directions, and they are arranging for their production as rapidly as circumstances will permit. Some of these have been or will be published. Among the former is a Report on the Resources and Production of Iron and other Metalliferous Ores, prepared by the Secretary to the Iron and Steel Institute. A new edition of this, now in preparation, will include a number of corrections and alterations, as well as the available information regarding the metalliferous ores of those countries which were omitted from the first issue.

The same section of the Standing Committee on Metallurgy have entrusted the preparation of a survey of the field for research in tungsten to a Sub-Committee under the chairmanship of Sir Robert Hadfield. On the advice of the non-ferrous section of their Standing Committee on Metallurgy, the Council have also appointed a Committee consisting of members of the Institution of Mining and Metallurgy, of the Institute of Metals, of the Engineering Standards Committee and of the industries concerned to prepare two surveys giving the existing knowledge and practice, so far as these can be ascertained, as to the zinc industry and as to the smelting and refining of copper and the qualities of copper and the copper alloys. A special committee of the Standing Committee on Engineering has been asked to prepare a memorandum on the field for research into Lubricants and Lubrication, with an analysis of the problems involved, and a suggested scheme of research.

Surveys of Resources.—Although the survey of promising fields for research and the documentation of existing information are necessary preliminaries to new work and fall consequently within the province of the Council, it is otherwise with the survey of what may perhaps be called natural phenomena and resources. Geological survey, both economic and scientific, geodesy, oceanographical survey and the related fisheries survey, meteorology, the survey of biological products of all kinds, even the survey of population of which the census is a part, are distinct from, though complementary to the Council's activities; yet they must be adequately organised and carried out, if their own work is to be adequately done. Reference was made to some of this work in the report of last year, where the importance of a systematic survey of the mineral and other resources of the Empire was emphasised and the hope expressed that this matter might be considered by the Committee appointed by the Prime Minister to consider our trade and industrial policy after the war. This matter, and in particular the survey of the mineral resources of the Empire, has been much discussed since then. In September, 1916, the Chairman of the Council received a joint memorial from the Iron and Steel Institute, the Institute of Metals, the Institution of Mining Engineers and the Institution of Mining and Metallurgy, pointing out that a

great deal of overlapping and confusion exists by reason of the large number of Departments concerned with the collection of information bearing on the sources of supply of minerals and the production of metals, and urging the view that the organisation of a central Department of Minerals and Metals was imperatively necessary in the interests of the Empire. While the Council agreed that an effective co-ordination and development of existing machinery is of great importance and in some cases a necessary preliminary to their own work, they considered that the question was beyond their reference, and accordingly asked the Committee of Council to place the memorial, together with the Council's observations, before the proper authority.

"Science and Industry," etc.—The publication of the first number of "Science and Industry" marks the beginning of work which the Council expect to be a permanent part of their activities. It opens with Mr. A. P. M. Fleming's account of the provision made for industrial research by public institutions and manufacturing firms in the United States of America. The Council have also begun the issue of a series of "Bulletins" intended to convey scientific information, useful to the industries of the country and based upon research work undertaken at the public cost. The first "Bulletin" is a "Memorandum on the means to be adopted to diminish the decay of Timber in Coal Mines," which will be circulated to the mine-owners concerned by the Controller of Coal Mines.

Refractories.—The Institution of Gas Engineers have long supported a research under Dr. Mellor into refractories, conducted at the Central School of Science and Technology at Stoke. The growth in this work has led the authorities of the School to approach the Department for aid towards the cost of a much-needed extension of their laboratory for refractories.

Heat Treatment of High-Speed Steel.—Valuable results have emerged from the experiments in the heat treatment of high speed steel which have been conducted for some time past by Mr. Dempster Smith for the Manchester Association of Engineers at the School of Technology in that city. The Department made a grant in 1915-16 sufficient to cover the cost of the research, with the exception of certain materials and apparatus (found by the firms in the Association) and the cost of housing, light and power, which were contributed by the School of Technology.

Personal Grants to Research Workers.—In two cases the Council have recommended grants for special apparatus. These were in effect personal grants to individual research workers. When the Council reported last year, they had recommended maintenance grants to nearly 40 individuals under a provisional scheme there outlined, but a number of these were unable to begin work, mostly because they were called to the Colours. The actual awards made during the session 1916-17 amounted to 36, of which 24 were to students being trained in the methods of research (of whom 6 were women), 10 were made to independent research workers, and 2 were made for research assistants. The Committee of Council have placed a sum not exceeding £6,000 at the Council's disposal for grants to research workers to be made during the session 1917-18, and they intend to continue the experiment of last year.

The Encouragement of Inventors.—The Council have given considerable thought during this year to the question of encouraging inventors. The cases which have come before them fall into two or possibly three classes. In the first class are patentees. In most of these cases the applicant was informed that the Department could not assist in the commercial exploitation of patented inventions. The second class is that of inventors, who submit suggestions or ideas for investigation. They are advised if they wish to retain proprietary rights in their invention to obtain provisional protection before submitting details of their invention to the Department. But if an inventor is not prepared to do this, he is asked to make a full statement of his invention in confidence to a representative of the Department. The third class consists of the makers of vague and impracticable suggestions.

Assistance to Individual Manufacturers.—The Council have also received a number of applications from individual firms asking for assistance in dealing with difficulties encountered in the course of manufacture. The co-operative Associations for Research will no doubt prove very useful to their constituent firms who are in difficulties of this kind, but it will take time for all the many industries of the country to organise themselves, and meantime the Council will do their best to assist inquirers to obtain the best advice available.

Other Topics.—The Council deal with other topics of interest to our readers such as hardness tests for journal and pins, flow of steam through nozzles, notched bar impact tests, superheaters, concrete, and many others. The Report (Cd. 8,718) can be purchased through any bookseller or directly from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2. Price 3d. net (by post 4d.).

PLATINUM SUPPLY OF THE WORLD.—In 1916 the crude platinum mined in Colombia, estimated at 25,000 oz., was refined in the United States, and reports received from domestic refiners show that 28,088 oz. of metals of the platinum group was recovered by them from all sources, foreign and domestic, of which the bulk, 24,518 oz., was platinum. The following table shows the estimated output of crude platinum of the world during the last three years, in troy ounces. Borneo and Sumatra produced 200 oz. in 1913, but no figures are available since that date.

Country.	1914.	1915.	1916.
Canada	30	100	60
Colombia	17,500	18,000	25,000
New South Wales and Tasmania...	1,248	303	222
Russia	241,200	124,000	63,900
United States	570	742	750
Total	260,548	143,145	89,932

THERMALINE.—Thermaline is a gas used for welding and cutting in the same manner as acetylene. It is, in fact, acetylene enriched with the heated vapours of crude oil. The special feature in its production is the use of cartridges of material, consisting of alternate layers of calcium carbide and sawdust soaked in oil. It is necessary to wash, purify and cool the gas. It is generated automatically in a portable apparatus as needed and delivered to the torch at 15 pounds pressure. There are several claims made for it. It is heavier than air, and it is said it can be used at a lower pressure slightly over 1,400 pounds and the the ordinary atmospheric temperature, but is not explosive when liquefied; the explosive ratio is from 12 per cent. to 30 per cent. air. An excess of oxygen is not required in the welding flame, so that there need not be any reduction of the carbon in the iron or steel which is being welded, thus producing a soft weld.

Moulding Fly Wheels.—II.

By Joseph Horner.

Because flywheel arms have often fractured when running at high speeds, is the reason why arms of wrought iron are cast into rim and boss, Fig. 24. In this case either full patterns or segmental patterns are used, the first for the smaller standardised wheels, the second for the largest, and also for executing occasional orders for wheels in any dimensions.

In the first kind, the patterns are made precisely like their castings, the place of the arms being represented by prints for their reception, and extending from rim to boss. The rim is built up with segments, the rim bosses are turned and fitted, the central boss constructed, and the arm prints are turned and fitted between. It is better to turn the bosses in halves, and cut semi-circular recesses in them to receive the arms than to merely fit the arms to abut between the boss faces. The first makes a vastly stronger job than the second does, in which displacement of the prints from the centres of the bosses is certain to occur. It is not necessary to divide the main pattern through the centre, although it may be done. In the case of a rim with a periphery straight across, the sand joint

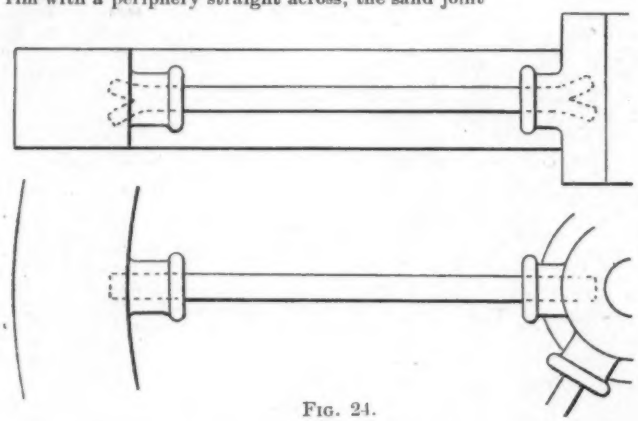


Fig. 24.

is made along the top face of the rim on the outside, and down to the centre of the arms inside. This entails a lift against the inner edge of the rim, which lift need cause no trouble if a little taper is imparted there, or, better still, a very slight convexity. In the case of a rim which has a convex periphery the outside joint must be made to the centre, but still the pattern need not be divided, since the curve of the rim will favour the delivery of the sand. If the edges should break down slightly, mending-up is readily done. The objection to dividing these patterns is the flimsiness which results, not in the rim, but in the arms and arm bosses. The only secure method to adopt then is to plate the halves, as illustrated in the previous article.

When a large wheel is made segmentally, the sectional piece for the rim is prepared long enough to cover the distance well beyond two adjacent arms, in order to include two arm bosses on it to ensure correct location of these. Fig. 25 shows one of these bosses on a segment. It will be noticed that the upper halves of the bosses are masked by a core print, which indicates that these halves are formed by cores, while the lower ones are produced by the actual half-boss and its half-print. The top of the mould is therefore plain. To attempt to mould the top over a segmental pattern containing the upper halves of the bosses would be extremely difficult, if not impracticable, involving resetting of the top for ramming each pair of bosses as often as the segment piece was moved round into a new position. This would entail useless trouble, without resulting in accuracy. Making the top halves of the bosses in cores, a plane cope is used. The dimensions of the top prints are not required exact, excepting their thickness. The only essentials are that they shall afford enough sand in the cores, and that they shall have ample taper.

The pattern bosses are jointed and turned in

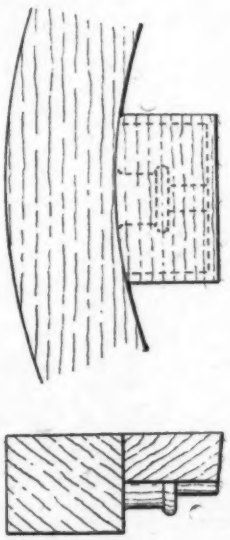


Fig. 25.

halves, Fig. 26, being secured either with a paper joint through the centre, or with a couple of screws as shown. Each boss then serves for attachment to two top core prints. A half boss is also required for the core box, Fig. 27, which, as will be noticed, is tapered at the sides to correspond with the taper in the core print, in Fig. 25.

The pattern for the central boss, Fig. 28, is made complete, and divided through the centre, and it carries the arm prints. These bosses vary in their shapes. They may be plain and parallel, or projecting arm bosses may be used like those which come next the rim, as in the sketch. The latter has the more pleasing appearance, but the former is better for casting, as being less liable to occasion blow holes. Either is satisfactory if due care is taken in pouring.

The rim segment is rammed on a levelled bed of sand, being moved round through distances corresponding with the boss centres, as described in the last article. The prints afford the means of cor-

rect resetting at each remove. The central boss is rammed in a small moulding box separately, and preferably in core sand, to be dried. The box must either be a special one, with holes in its sides to pass the arms through, or its joint faces must be kept asunder with thickness pieces, not less in thickness than the diameter of the arms. By the adoption of either of these methods, the arms are passed between the box parts into the boss mould.

When the rim segment has been worked round, and its mould completed, the arms are laid in, and the boss cores, made in the box, Fig. 27, are placed over the arms. Enough sand is tucked under the arms to afford support to them in addition to that provided by the print impressions in the mould, and by the covering cores, but the sand need not be extended beyond the distance necessary to provide that support, since there is no connection between the pouring of the rim and that of the boss.

The rim is covered as stated with a plain top, that is one which has a plain surface. This may be swept with a strickle, or rammed on a level hard bed of sand. Through it the ingates and risers are made with plain round git sticks. A small wheel may be poured at one place only with a single runner. A large one is better run on opposite sides, and especially so if the rim is of light section. The risers or flow-off gates, one or two in number, may be placed midway between the runners, or if only one runner is used then on the side opposite to it. They relieve the mould of strain, and may serve in some degree as sullage heads. It is desirable to feed a heavy rim with fresh metal, pumping through the runner or runners.

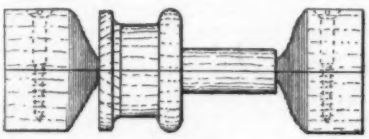


FIG. 26.

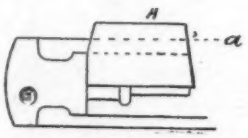


FIG. 29.

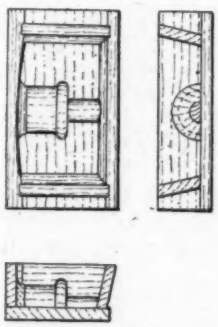


FIG. 27.

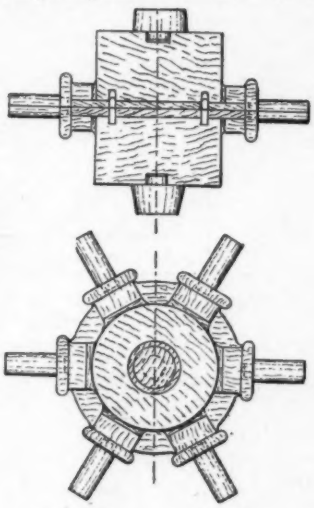


FIG. 28.

The arm bosses are a tender section of the mould, because blow holes are very liable to form there in consequence of the metal coming into contact with the cold arms. The way to prevent or lessen this risk is to warm up the arms to a low red heat previous to inserting them in their print impressions. An additional precaution is to dip the ends in tar. Another is to oil them, but the tar is the better protective. Finally, a small riser is put over each boss, and an excess of metal is poured through the mould, so that a small volume will run over at the risers.

The central boss is not poured at the same time, but some hours later than the rim, in order to allow the rim to cool and take all its shrinkage, after which the boss is poured. The rim being cast at night, casting of the boss may be deferred until the next day. If both were cast at the same time, the shrinkage of the rim would push the arms inwards, and either fracture the boss, which has practically no shrinkage, or else bend the arms.

The boss mould is centred by measurement and levelled with a spirit level. It is divided through the middle plane in order to permit of the insertion of the arms, so that the first setting is that of the lower half of the mould. This being centred, and levelled, the arms are inserted, no further security being required, except the lowering of the top mould on them and its weighting. One ingate and one riser are used, and an excess of metal must be poured, and the boss fed.

When a rim is of the section seen in Fig. 29, the arms being cast in, the covering core, instead of being flush with the top face of the rim at *a*, must be carried up into the top box in order to provide a sufficient body of sand in the core above the beading of the boss. The print need not be carried up to the corresponding height, as shown in Fig. 29, unless a complete pattern is made, in which case the top is rammed directly on the pattern. When a segment is used, and worked round, the portions of the prints which come in the top above the plane *a* in Fig. 29 are inserted in the top as separate pieces. There are several ways of doing this, care being necessary to secure the correspondence of the top and the bottom portions of the mould.

The portions A of the prints which come in the top in Fig. 29 can be prepared, and be bedded in the top and set by measurement in the sand. A circle is struck on the face of the top, and divided into six, if the wheel has six arms, and centre lines corresponding are drawn radially; the print pieces also having centre lines, are bedded in by these lines, and the circle of the rim struck. As the thickness of the supplementary pieces A is not great, the sand is dug away with a trowel from the top, previously rammed on a dummy mould, or swept directly, and the print pieces are inserted, and the sand made good around and beneath them. Unless these pieces exceed ¾ in., or 1 in., in thickness they will not foul the box stays.

When doing work of this kind, independent

measurements are not so reliable as others are in which a transference of some kind takes place. In these, the bottom having been rammed first, with its print impressions, these last are imparted to the top which is located in the position that it is to occupy at the time of casting, being guided by stakes driven into the sand, and in contact with lugs or abutment strips cast on the box sides.

One method is to lay strips of brown paper round the edges of the print impressions in the bottom, moisten their upper surfaces with spots of clay water, and lower the top on them. Some of this will stick on the top sand, and the paper adhering to it will come up on the top sand, and afford a fairly approximate guide to the moulder by means of which he will cut out the sand and ram the impressions round a top print. Another is to dust over the surfaces of the bottom mould with chalk, or lime, or with parting sand, and press the top down on this. Some material will be transferred, and become a guide as the brown paper was to the bounding edges of the print impressions. More nearly accurate perhaps than either of these methods, is to drive long nails, or else strips of thin hoop-iron into the print impressions in the bottom, making them hug the sides closely to coincide with the edges, and projecting above them by about ¼ in. When the top is lowered on the bottom these will enter the top sand, and mark the outlines of the print impressions required.

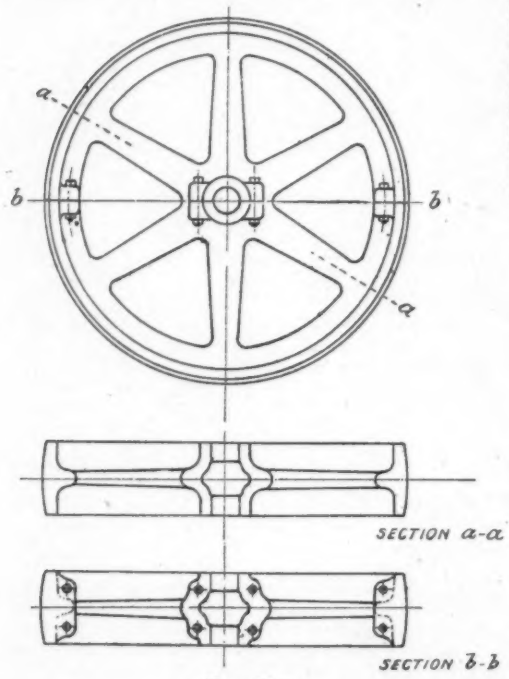


FIG. 30.

Flywheel bosses are frequently split to eliminate shrinkage strains, and are afterwards bonded. The splitting is done at three equidistant places by the insertion of iron plates in print impressions. These fall out consequent on the shrinkage of the arms towards the rim. They are replaced with other thicker plates and secured by the bonding of the boss with wrought iron rings shrunk around annular recesses on the ends of the boss.

Flywheels are cast in halves, when, if solid they cannot be got over the ends of their shafts. Two methods of division are adopted, one being to use a complete pattern and lay splitting plates in the impressions made by means of prints; the other is to mould the halves separately. In the majority of instances the first method is adopted, the second being chiefly reserved for the heavier wheels.

The objection made to casting in separate halves is that the halves are liable to shrink unequally, with the result that they will not match when put together in the joints. The advantage is that allowances for tooling to secure a neat, close-fitting union can be made, and plates, which are somewhat clumsy, need not be inserted. When splitting plates are used, similar plates have to be bolted up in the casting. The split faces also are liable to be rough and blown. Generally, when a light wheel is split, the division is not carried quite through the rim, but stops short at about ½ in. from the periphery. The rim is thus compelled to shrink equally, and the ½ in. of solid metal is readily broken through after the casting has become cold.

In splitting flywheels, bolt lugs are fitted next the rim and the boss, Fig. 30. Frequently lugs are fitted next the boss only, and cottared joints are made in the rim, these being neater than lugs.

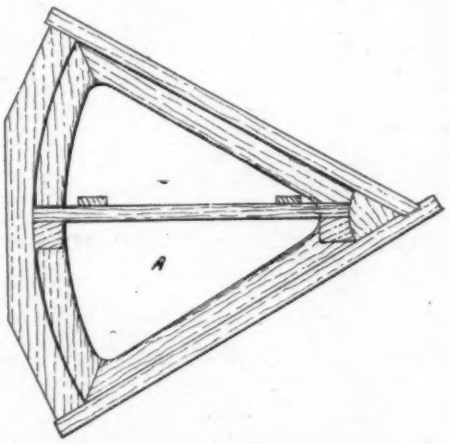


FIG. 31.

Splitting plates are made of wrought iron of from ⅛ in. thick to ¼ in. thick. It is necessary to cover them on both sides with a coating of black wash. Sometimes a thin layer of loam is used instead, which is blackened over. Unless this is done, and the plates are in addition dried thoroughly, and warmed before they are inserted in the mould, the metal will bubble against them, and the casting be blown in the vicinity.

Frequently the bolt holes are cast in the lugs. Then the cores are put, not in print impressions, but in holes drilled in the plate at the bolt centres; the cores stand out from each side as far as the outer faces of the lugs against which they abut. In good work, the holes are enlarged by drilling

and reamering; but if it is intended to do that, it is better not to core them, but to drill through solid metal. Then one half casting is drilled first from the joint face, after which the other half is marked from the first and drilled. The holes may be reamed together, using a hand reamer. When wheels are cast in halves, the better way, and the neater, is to make each half separately, face the joints, drill, and reamer the bolt holes, bolt the two together, and then turn the rim, and bore and face the boss. A full complete half pattern is not necessary in this case, unless considerable numbers are required. The arm can be made in cores from a box, like Fig. 20 in the previous article, and the rim can be rammed round against a block. For a half wheel, like that in Fig. 30, a bed is rammed, vented down to a coke bed, and levelled, and a circle struck on it to the diameter of the rim at the outer edges. The block is shifted round on this after each section is rammed until the half rim is completed. This only forms the periphery, and the top of the block affords a guide for sleeking the top joint face by. The joint face to form the half wheel, plus tooling allowance, is made by supporting a board across the mould with a vertical face, and ramming the jointing face against that. The whole of the interior sections of arms and rim are made in cores.

A core box is shown in Fig. 31. After having been used first for the two complete cores in each half rim, it is seen as altered for the half cores. These are rammed in the portion A of the box, against the face of the bar, which face gives the extra allowance for tooling in the joint, and carries the bolt lugs that come next the boss and rim. A plain top is used to cover the cores and rim. Runners from vertical ingates can be brought in horizontally through the face of the joint to the rim spaces at both ends, and a vertical ingate can be placed over the boss.

Sands used in Metallurgical Practice.

A paper recently read before the Society of Chemical Industry, by PROF. P. G. H. BOSWELL, dealt in part with "Sands Used in Metallurgical Practice." In metallurgical work, he said, the sands required might be classified into those used for moulding, for lining hearths and furnace bottoms, and for silica-brick-making. Moulding sands might be subdivided into those used with a natural bond and those with an artificial bond. Refractory sands could not yet be discussed exhaustively, the requirements varying with the kind of metal made, the ores used, the type of furnace, and the craft and prejudices of the user. Accumulation of facts was the chief necessity at present as regards refractory materials, to include analyses of successful and likely supplies, and carefully recorded results of their trial in the works on a commercial scale. Chemical, mechanical, and mineralogical analyses were required. The precise part played by small quantities of so-called impurities in sands was not well known. They might behave as catalytic agents in facilitating conversions. Titanium was always high in fireclays, most of which were very refractory, and as rutile (or other titanium mineral) was not to be found, it would seem that the titanium compound was scattered throughout the clay, perhaps in a colloidal or clay-like form. Sands for refractory furnaces should be as silicious as possible, or otherwise should contain only silica and alumina. Most sands were quartzose, the best containing over 99 per cent. of silica. The highly aluminous sands of Derbyshire, practically free from lime and alkali, were valuable for making silica bricks. For fettling Siemens-furnace hearths, lining re-heating-furnaces, etc., it was better, instead of using highly refractory quartzose sands, to use a sand with a small amount of alumina, iron, or even alkali sufficient to make the sand-grains frit and bind together at their angle of rest on the banks of the hearth. Mr. Cosmo Johns had expressed the opinion that the melting point of quartz, as distinct from that of cristobalite, might be achieved in the presence of small quantities of impurities in the sand. He suggested as the permissible range of single impurities:—Alumina up to 2 per cent or more; ferric oxide up to 0.5 per cent.; lime, 0.5 per cent.; magnesia, 0.5 per cent.; soda or potash, 0.15 per cent.; if more than one be present, the amounts should be reduced proportionately.

Analyses were given of Leighton Buzzard, Lynn, and Belgian sands, all containing over 99 per cent. silica, which had proved very suitable for lining Siemens-furnace hearths, for the beds of re-heating furnaces, etc. Also of Derbyshire sands and East Anglia sands, which had made good silica bricks:—

	Silica.	Alumina.	Iron oxide.	Lime.	Loss on ignition.
	%	%	%	%	%
Derbyshire 1 ...	74.52	18.04	0.05	0.19	7.20
" 2 ...	90.40	6.56	0.18	0.16	2.48
East Anglia ...	94.57	1.99	1.40	nil	0.91

The East Anglian specimen also had 0.22 per cent. magnesia, 0.72 alkalies, and 0.19 sulphur trioxide. In the above cases the chemical composition indicated definitely the properties of the sands and their likely behaviour in furnaces. The same was true of high-silica sands used with an artificial bond for steel-casting. But not so in the case of moulding sands with a natural bond, though a chemical analysis of each grade would give valuable information. In high-class moulding sands with natural bonds, coarse sand and clay predominated, fine sand and silt being subordinate and often practically absent. The clay with the water it absorbed provided the binder which held the coarse quartz grains together even at high temperatures. The clay should be as refractory as possible, though kaolin had no great binding properties. Fireclay was occasionally added to silica sands as a binder.

In all good moulding sands the predominant coarse sand ensured that the mould should be open, with adequate pore space (probably about 40 per cent.) for air, vapours, and gases to pass freely, while the clay-grade provided the refractory bond.

In the Bunter red sands, like those of the Birmingham district, the bond was ferric oxide instead of clay, a thin pellicle of iron-oxide surrounding each grain of quartz. This iron-oxide had great power of holding a film of water by surface tension, thus making a strong bond between the grains. All good moulding sands carried water readily, many of them holding 10 or 12 per cent. of water without being really wet. Such Bunter sands were much used for casting iron and brass, and for steel under certain conditions.

Mineral analysis was much less tedious than chemical analysis, the minerals of different densities being separated by means of a heavy liquid, and examined under the microscope. In this way the presence or absence of harmful minerals could soon be ascertained, and even the relative proportions.

Cast Iron: Past, Present and Future.*

By W. Mathews.

Mankind in a primitive age discovered that iron ore in contact with the fuel of a fire became reduced to a malleable mass. Owing to the relative purity of the ores used in early times and the consequent high melting point of the iron, it was seldom that the iron was reduced to the liquid condition. This indicates that in the use of iron the blacksmith preceded the iron founder. In all probability cast iron was an accidental discovery due to the use of easily reducible ores together with a better form of furnace and stronger air draught. Although cast iron appeared late, the art of moulding had long been practised, in the making of bronze castings, and considerable skill had been shown by the ancient brass moulders.

At what date cast iron was introduced into this country is not quite clear, but there is evidence of its use in the 15th century. We know that in the following century it was used in casting cannon, while in the beginning of the 17th century the celebrated Dud Dudley's patent was granted by King James for the making of pig-iron—"The mysterie and arte of melting iron oares, and of making the same into iron works or bars, with sea coales, or pit coales in furnace with bellowes."

Dudley also put on record a list of some of the castings he produced—"I also made all sorts of cast-iron wares, as brewing cysterns, pots, mortars, and better and cheaper than any yet made in these nations with charcoles."

The advent of the steam engine in the middle of the 18th century created a large demand for iron castings, and it is from that period that our modern blast furnaces and iron foundries may be said to date. From that time to the present the demands of the foundryman have been steadily increasing as to the quality of the articles produced. In the early days of the steam engine boiler pressures were low, and the consequent stress on cast-iron cylinders was easily met. But the introduction of the railway locomotive rendered it imperative that more attention be directed to the turning out of the reliable castings necessary for such severe working conditions. The evolution also of the steam engine for marine propulsion from the simple to the compound, then to the triple and quadruple expansions, with their gradually increasing pressure, all tended to make the lot of the iron founder a more strenuous and anxious one.

In the first half of the 19th century other outlets were found for the use of cast iron, in the construction of viaducts and bridges across valleys and rivers for the purpose of carrying the railway lines then being laid down. One of the most notable cast-iron bridges in the world stands a stone-throw from this meeting place, viz., the famous High Level. From contemporary records we find that the castings were made by Messrs. Hawks, Crawshay & Company, Gateshead Iron Works, and that a Mr. Clarke is named as the foreman founder. It is surely not out of place to record our tribute to this foundryman of a bygone generation for the excellence of the work turned out by the men under his supervision. Great care was exercised in the selection of suitable irons, a careful series of experiments were made, and eventually it was found that the best results were obtained from a mixture of anthracite Welsh cold-blast, along with Ridsdale and Scotch hot-blast. The total amount of cast iron used in the structure of the bridge amounts to 4,728 tons. When we consider that from the piling of the river for the pier foundations until the last bolt was driven home a period of only three years had elapsed, we must pay a tribute of respect to all concerned, and especially to the memory of that great Northumbrian, Robert Stephenson, an engineer who did believe in cast iron.

Directing attention now particularly to the question of suitable irons for steam turbines and internal combustion reciprocating engines for marine propulsion; when it is remembered that the efficiency of a turbine—especially of the Parsons' type—depends to some extent at least on the fineness of the tip clearances, it will be readily seen that no distortion or growth of cylinder castings should take place if these fine clearances are to be maintained during actual running conditions extended over long periods. It has, however, been established in the case of some large casings at least that such growth or distortion has taken place, and the problem for founders is the selection of irons which shall be least susceptible to such influences.

As this question is intimately connected, and in a more acute degree, with the question of cast iron for Diesel cylinders, it will be better, perhaps, to hasten on to the consideration of this type of motor. A very great difference of opinion exists as to the future of the Diesel engine amongst those who may be presumed to form a sound opinion; but, as foundrymen, we may remain passive while the matter is thrashed out, though on the principle that he is a wise man who prepares for all possibilities, we will assume that the Diesel engine has a big future.

During the past few years British foundrymen have, generally speaking, had little experience of Diesel work except in a few instances in particular areas. Our business now is to try and grasp the problems inherent in the Diesel cylinder, and having got that far to consider the character of the irons which are most likely to remove, or at least alleviate, the troublesome features alluded to.

The operations of the Diesel engine involve fluctuations in pressure from ordinary atmospheres to 500 lbs. The temperatures reached are also of vital interest to the foundryman. The compression of the air in the cylinder raises the temperature to about 1,000 deg. F.; at that instant, the oil fuel is injected and combustion rapidly takes place. The oil valve is so arranged that the admission of fuel lasts for about one-tenth of the stroke. During this moment of combustion the temperature rises from 1,000 deg. F. to something like 3,000 deg. F. The temperature then falls rapidly, owing mainly to the conversion of heat into work, and also through the transmission of heat through the cylinder walls into the water-jacket.

The high temperatures mentioned constitute the

* Abstract of Presidential Address before the Newcastle Branch of the British Foundrymen's Association.

very heart of the problem for founders of Diesel engine castings. The vital castings are cylinder liners, cylinder covers, and piston tops. Attempts have been made to use cast steel for such parts, but the results have not justified, so far as is known, the continued use of this material. One reason given is the high co-efficient of expansion of steel, which presumably renders it unsuitable for use in conjunction with cast iron. Some Continental makers have also tried bronze for the parts described. Cast iron, however, is almost universally adopted, and the conditions to be satisfied are laid down as follows:—(1) High tensile strength; (2) hardness; (3) shock-resisting properties; (4) machineableness; (5) resistance to growth. The last condition is the most difficult to comply with, and, indeed, the attempt to get a cast iron suitable for all the conditions named ends in a compromise.

Growth in cast iron has been described as the deterioration and increase in volume of the structure of the metal due to the rapid and fluctuating temperatures to which it is exposed. The phenomena of growth was investigated by Dr. Carpenter some years ago, and it may be stated definitely that no iron which contains free carbon and silicon is immune from growth. The graphitic carbon, and more especially its condition together with silicon, seems to be the determining factors in this matter. The coarser the character of the graphite flakes the greater the tendency to grow, because the slits occupied by graphite afford avenues for the penetration by high-temperature gases into the inner mesh-work of the iron, these gases attacking probably the silicon and forming some combination of oxides of silicon. It is evident, therefore, that great care must be exercised in the selection of pig-iron for such castings.

The question of carbon-silicon equilibrium has been gone into by Mr. Cook, and the empirical formula he has given for ascertaining the limits of these constituents for different classes of castings is worth noting. Total carbon for the castings in question should not exceed 3.25 per cent. with combined carbon 0.6 per cent.; this percentage of C.C. gives the maximum tensile and transverse combined.

The free carbon should be in a very fine state of division, approaching to what is known as temper carbon. Carbon in pig-iron is derived from the fuel in the blast furnace, and the character of the free carbon seems to be determined by the conditions under which the furnace is working. It has been established, I think, that the higher the pressure and the higher the temperature of the blast, the more the carbon absorbed by the ore in process of reduction, and in particular the larger the flakes of free carbon. Blast furnaces working under such conditions do not produce suitable irons for the castings under discussion.

As regards the other constituents for the desired iron, silicon should be about 1.2 per cent., manganese 0.7 per cent., and sulphur 0.1 per cent. As to the phosphorus content, there is a very marked difference of opinion between British and Continental founders. Abroad they stipulated a phosphorus content of not more than 0.3 per cent., while, as a matter of fact, some good castings have been supplied in this country with phosphorus as high as 1.2 per cent. On the face of it this is a matter which requires more investigation. The argument against high phosphorus is that it diminishes the shock-resisting properties of the metal, while the arguments for are the increased fluidity of the metal and that in particular it lowers the co-efficient of expansion.

Reference was made earlier to turbine cylinders and growth troubles. Possibly the discussion on iron for Diesel work has afforded a clue to the disappearance of such vexatious experiences in turbine cylinders, although the conditions are different.

The matter of cupola working in the foundry also requires attention. In a cupola a proper ratio should be established between fuel and air; too little air may mean absorption by the metal of some of the excess carbon in the fuel, while too much air on the other hand may mean oxidation troubles. For castings of vital importance it is a question whether the air furnace would not be superior to the cupola, as the metal does not come into contact with the fuel.

In the past British engineers have in a number of cases imported from abroad either the pig-iron or the castings for the vital parts of the Diesel cylinder. Is it too much to urge that in the future (assuming again that this type of engine is likely to have a large vogue), our engineers should place all castings with home founders, and that British foundrymen, by an intelligent appreciation of the conditions to which their castings will be exposed, ensure that as far as possible the trust reposed in them is justified by results?

Industrial Re-construction.

THE COUNCIL FOR THE STUDY OF INDUSTRIAL RECONSTRUCTION have devised a scheme of industrial reconstruction which they present as the practical outcome of all the authoritative suggestions that have been made during the past three years for the organisation of our industries and the development of our trade and commerce. The first essential in any scheme for the fuller development of industry is the co-operation of Labour, and the manifesto just issued, signed largely by manufacturers and officers of employers' associations, is definitely an olive branch to Labour. It invites the workers to join with the management in the self-government of industry, and gives them an equal status and responsibility on the controlling body. It is earnestly hoped that Labour will recognise this genuine desire for co-operation and will consider without prejudice the possibilities thus opened to them. A meeting will shortly be arranged for the further explanation of these proposals. The signatories include Prof. F. Bacon (Professor of Engineering, University College, Cardiff), Prof. T. Hudson Beare (Regius Professor of Engineering, University of Edinburgh), Prof. J. A. Fleming (Professor of Electrical Engineering, University of London), Prof. John Goodman (Professor of Engineering, University of Leeds), Sir James Heath, Bart., Prof. Gisbert Kapp (Professor of Electrical Engineering, University of Birmingham), Mr. Wm. A. Baxter (Electrical Contractors' Association), Mr. H. Buchanan (Bristol Electrical Contractors' Association), Mr. J. S. Cornwell (Bedstead Manufacturers' Association), Mr. A. S. Culliwick (Midland Lock and Latch Manufacturers' Association), Mr. J. Hewitt (Barnsley and District Colliery Owners' Association), Mr. E. Keighley (Burnley and District Engineering Employers' Association), Mr. G. Lyall (Edinburgh Branch of the Electrical Contractors' Association of Scotland), Mr. H. E. D. Mabbott (Sheet Metal Workers Employers' Association, Manchester), Mr. J. J. McKeown (Belfast Electrical Contractors' Association), Mr. T. Phillips (South Wales and Mon. Iron and Steel Makers' Association), and Mr. T. B. Wright (Electrical Contractors' Association of Scotland).

New Experiments on Shock Tests and on the Determination of Resilience.*

By Georges Charpy and Andre Cornu-Thenard (Paris).

It will be remembered that, on the occasion of the Copenhagen Congress, and after discussing a report presented by M. Charpy, the International Association for Testing Materials appointed a special committee (Committee 26) to define the method to be adopted in conducting resilience tests, and to investigate the connection which exists between the results of these tests and the behaviour of metals in practice. The researches which form the object of the present Paper relate to only the first half of the question. Carried out in 1913 and 1914, they were intended to serve as a basis for the consideration of Committee 26, in order to frame suggestions for submission to the Congress which was to have been held in Petrograd in 1915. Most investigators who have published researches on bend tests of notched bars appear to have given up all attempts to obtain a series of results devoid of accidental differences. Some attribute such irregularities to the mode of testing itself; others challenge the homogeneity of the metal under investigation.

In regard to the second opinion, it is necessary to recognise that the bend test on notched bars possesses a degree of extreme sensitiveness, which serves to detect certain physical states not revealed by any other of the usual tests. This sensitiveness confers a special interest on resilience itself, and justifies a close study of the whole question. At the same time the authors conceived that it would be an advantage to submit their own tests to a certain number of competent persons for checking, and they have, with this object, invited all the members of Committee 26 to be present during the tests made at the laboratory of the Conservatoire National des Arts et Métiers by the staff of that Institution, after having settled with them the details of procedure. The report on these tests is annexed to the Paper.

I.—Preliminary Determinations.

The regularity of a series of tests will be satisfactory when the results all keep within a certain limit. In practice it suffices if the average relative divergence remains below 5 per cent. It was also necessary to establish clearly that irregularities in the results obtained were not due to some fault in the testing apparatus, but to the material tested. With this object in view the authors have employed unnotched bars in such a way as to limit the deformation to a well-defined bend without carrying it as far as fracture, so that the small local irregularities which may subsist from one point of the metal to another should not interfere to any appreciable extent. The authors do not lay particular stress on this portion of their researches, which have been described in the "Revue de Métallurgie," in 1913, but confine themselves to stating certain general results, an examination of which shows: (1) That unnotched bars, prepared with certain precautions, give results which are practically identical when the tests are made with the same apparatus and under similar conditions; (2) that the irregularities displayed by different notched bars, when submitted to the shock test, are attributable, not to the testing machine, but to the material itself under test.

* Abridged Paper read before the Iron and Steel Institute.

II.—Preparation of Sets of Bars of Uniform Resilience.

The authors have sought to avoid as much as possible chemical or physical heterogeneity in a test bar by cutting it always from the sound portion of a very large ingot. In the case of a steel of the semi-hard type (metal A), which served for the greater part of the authors' preliminary investigations, they cut their test-pieces, weighing 25 kilogrammes (about 55 lbs.) from a 45-ton ingot. Two slabs were taken from the bottom of the ingot, and etched first with iodine and then with sulphuric acid without displaying any heterogeneity.

One of the slabs was sawn in two and, after being annealed, was submitted to ball hardness tests over its entire surface. These tests showed an average hardness of 153.4 ± 5.6, that is to say, an average divergence of only 3.6 per cent. A number of drillings were then taken from various points for chemical analysis, which yielded very concordant results. The metal appearing to possess a satisfactory degree of homogeneity, strips of $100 \times 100 \times 300$ mm. were cut from the portion concentric with the axis, and from the median part of the ingot.

Each strip A, rolled into a square bar 34×34 mm., furnished one set of test-bars, which were annealed to remove the stresses due to rolling, machined to 30.5×30.5 mm., and submitted to heat treatment, that is quenching and annealing. After finishing, punching, and notching the bars they were tested by shock. In spite of all the precautions taken, the results showed all the irregularities so often noticed in resilience tests, while the hardness was practically constant in the different bars. Another set of shock tests was then made after planing off the outside skin of the bars, and the relative average divergence fell from about 40 per cent. to 8 per cent., while the hardness tests remained perfectly regular.

On the other hand, some experiments carried out on another steel lead the authors to believe that the temperature of rolling may influence resilience. In order to ascertain the extent of this influence on the metal A, they had two blocks rolled from their 45-ton ingot, one at about 1,200 deg. C., the other at about 800 deg. C. The bars thus obtained were annealed at about 900 deg. C. and cooled in the furnace. On removal the bars were quenched and annealed, then machined to 30×30 mm., punched, and notched. The authors had until then assumed that the more or less pronounced interstraining produced by rolling or forging would be completely removed by a suitable further heat treatment. The results obtained, however, proved that although this may be so in regard to the ball-tests, it no longer holds good in the case of the resilience tests. On the other hand, it had been found that not even micrography could reveal, after the treatment, any difference between the structure of the cold-rolled and that of the hot-rolled metal.

Taking advantage of the experience gained, a new block of metal A was turned, by rolling, into a bar of 35 sq. mm.; this, after a first annealing,

was cut up into portions capable of being rolled into bars 160 mm. long. These pieces were subjected to heat treatment (quenching and annealing) in the conditions described above, and then trimmed to 30 × 30 mm., punched, notched, and tested. The set was thus composed of five consecutive lengths cut from the same bar. The results of the tests still showed a divergence of 7.5 per cent., and, as it appeared to the authors at this juncture that the carrying out of the heat treatment might leave something to be desired, they decided to treat all the bars of a set simultaneously, in a bath of lead. The bars, after this treatment, were machined to 30 × 30 × 160 mm., punched, gauged, and notched. The tests carried out under these conditions on the metal A display greater uniformity to those previously obtained, the divergence in the last case being reduced to 3.6 per cent. Tests made on 10 × 10 mm. bars gave only a divergence of 1.2 per cent.

It now remained to confirm the results already obtained by checking their accuracy over a certain range in the scale of resiliences. For this purpose the authors took blocks of a metal "J," which was semi-hard and contained nickel (weight of original ingot = 25 tons), and of a metal "P," which was hard and contained chromium-nickel (weight of original ingot 2.5 tons), which were both treated in the same way as the bars of A metal. Each set comprised five bars, and the results obtained showed divergences of 0.7 and 2.7 per cent. in the case of metal J, and 1.5 and 3.3 per cent. in the case of metal P, as compared with 2.2 and 4.6, obtained with commercial copper (quenched from 200 deg. C.).

III.—Influence of Different Variables which may Intervene in Shock Tests.

Being possessed of very homogeneous material able to give results extending over the entire scale of ordinary resilience, the authors were in a position to study the influence of the different variables which may intervene in the course of shock tests. The method of operating is detailed below.

Method of Investigation Adopted.—The object in view was to ascertain if the variation of one of the conditions of testing had any appreciable influence on the results obtained with any given test-piece. For this purpose a set of ten bars, as uniform as possible, was made up, and the average resilience of the set ascertained by breaking, in the ordinary way, five of the bars. The particular factor to be investigated was then varied, and the remaining five bars were broken under the new conditions. If a variation in the average resilience occurred it was regarded as due to the influence of the change effected, and this influence regarded as negligible in practice when the difference did not exceed the pre-arranged limit.

Influence of the Height of Fall.—The influence of the height of fall of the weight in shock tests is often considered as influencing considerably the results. Opinions, however, differ as regards the degree. Mr. Belanger, for instance, claims decreasing resilience from unity to double and even more when the height of the fall is reduced from 4 m. to 1 m., while, on the other hand, Mr. Frémont gives differences in respect of certain steels which, although not recorded numerically, he appears to regard as even more excessive than those recorded by Mr. Belanger, but in the opposite sense. The tests made by the authors were carried out on two different pendulum machines, one having a maximum height of fall of 6.45 m., and the other 3.87 m. The test bars measured 30 × 30 × 160 mm., and had the Copenhagen notch. The results showed that the rate of shock was practically negligible within the limits to which the authors confined themselves (11.25 m. to 3.40 m.). This can be easily understood, under ordinary conditions, if instead of considering height of fall the mean rate of deformation be taken into consideration. Thus, for example, in the case of steel P, the height of fall may vary in the ratio of 7 : 1, and at the same time the residual rate of speed, after impact, may vary in the ratio of 12 : 1 without the average duration of the test varying more than $\frac{1}{10000}$ to $\frac{1}{10000}$ of a second; it was to be expected, therefore, that the resilience result would not record this variation to any appreciable extent. This result may be likened to those obtained by Messrs. Sarrau and Vieille in their well-known experiments on the measurement of explosive pressures, namely, that the deformations produced on the crushed cylinders, per given pressure, remained practically identical even when the rate of applying the pressure varied from $\frac{1}{10}$ to $\frac{1}{10000}$ of a second. M. Charpy has already shown that in order that the results of the tests should be influenced to an appreciable extent it was necessary that the average duration of the deformation should vary from 2 or 3 minutes to 1 second. Under such conditions the diminution of the crushing reaches 8 to about 10 per cent.

Influence of Weight of Drop-Weight and Anvil-Base.—The authors next decided to institute comparisons between two machines of the same type, but of different sizes. The question of height of fall being eliminated, the two only variables whose influence could affect the results were thus the weight of the drop-weight and of the anvil-base. Two pendulum drop-weight machines were employed, one of 307 kilogrammetres (drop-weight, 96.25 kgs.; height of fall, 3.87 m.; distance apart of supports, 80 mm.), and the other of 47 kilogrammetres (drop-weight, 32.14 kgs.; height of fall, 1.49 m.; distance apart of supports, 80 mm.

Ten test-bars (20 × 20 × 107 mm., notched to one-half) were divided into two sets of five each. One set was tested on the large, the other set on the small machine.

Taking into consideration the mean relative divergences determining the accuracy of the test the results obtained on the two machines may be regarded as practically identical. As however the small machine was one of an old type and somewhat worn the tests were repeated on a new machine, the size of the test-bars being reduced to 15 × 15 × 80 mm. The larger machine was the same as used before, but the distance apart of supports, 60 mm.; the new machine was a 30-kg.-metre pendulum drop-weight machine, drop-weight, 22.31 kg.; height of fall, 1.45 m.; distance apart of supports, 60 m.m. The weights of the frames of these two machines were 1,800 kgs. and 190 kgs. respectively. The weights of the anvil-bases were roughly proportional to those of the frames.

In this case the uniformity of the individual results in each series was thoroughly satisfactory, and the average resiliences did not differ more than 0.74 kgm., that is, by about 3.9 per cent. of the highest figure recorded. It may therefore be assumed that, within the limits of accuracy reached in these experiments, the weight of the drop-weight and that of the anvil-base did not influence the drop-test result, although the larger machine was too big and the smaller too small for the work.

Tests with Different Types of Machines.—The authors next set themselves to investigate whether the different types of machines in use gave comparable results.

Their first experiments were made with a pendulum and a vertical drop machine. The authors tested a group of 4 *n* uniform test-bars, and determined the average resilience of the set by breaking 2 *n* on a pendulum machine. Assume T to be the average work which produced, within about 2 per cent., the fracture of these 2 *n* test-bars. They then calculated the height H at which it was necessary to liberate the weight P of the vertical machine to satisfy the relation PH=T. This done, the weight P was allowed to fall—(1) From a height H $(1 - \frac{15}{100})$ on *n* of the remaining test-bars. Neither of them broke. (2) From a height H $(1 + \frac{1}{100})$ on the *n* test-bars remaining. They all broke.

The authors successively made P = 18 kgs. and 75 kgs. in the above instances. The results were uniform, despite the variation in the weight of the mass and in the height of the fall.

From a qualitative point of view, therefore, the results obtained with the pendulum and the vertical drop machines were perfectly comparable; it remained to estimate numerically this comparability. For this the authors fixed on the vertical drop machine an Amsler-Laffon recorder, which allows of the exact determinations of the rate of speed before and after fracture, and enables the energy absorbed in fracturing the bars to be calculated accordingly. The bars employed were of the Copenhagen type, and measured 30 × 30 ×160 mm. In both machines the distance apart of the supports was 120 m. The results obtained were as follows:—The two average resiliences differed by only 7.1 per cent. of the higher figure. Considering the makeshift nature of the arrangements the results obtained with the vertical drop and with the pendulum machines may be regarded as being in close agreement.

The experiments at the Conservatoire des Arts et Métiers were made with Charpy pendulum machines of 300 and of 30 kg.-m., with a vertical drop machine and with Guillery rotary machines of 275 and 60 kg.-m. It will not be necessary to give again in detail the results of the comparison of the pendulum machines with the vertical drop machine, which only served to confirm the results obtained by the authors. The comparative tests made on the Guillery and Charpy machines, however, deserve notice. They were practically identical notwithstanding the essential difference in principle which characterises the two types of machine. The results recorded would have been even more closely in agreement if the calculations of the tests had been in both instances carried out in the same manner, but the scales of the Guillery machines do not take into account the kinetic energy absorbed by the projection of the fragments of the test-bars after rupture, whereas the graduations of the Charpy pendulum machines take this energy into consideration.

Influence of the Type of Notch.—All the preceding experiments were carried out on test-bars of the Copenhagen type or on its immediate derivatives, the shape and dimension of the notch not having been as yet universally adopted. It appeared useful, therefore, to determine the influence of these conditions on the value of the energy of fracture per sq. cm. With this object the authors experimented, therefore, on bars of 10 × 10 × 53.3 mm. and adopted the four types of notches described below, the results being obtained on a pendulum machine of 30 kgs.

A.—Round notch: Residual section 10 × 5 = 0.5 punched with a die and saw-notched.
B.—Round notch: Residual section 10 × 7 = 0.7 punched with a die and saw-notched.
C.—Angular notch: Residual section 10 × 7 = 0.7 made with a tool and planed.
D.—Residual section 10 × 9 = 0.9, made with a blunt saw.

The tests showed the following facts:—Leaving out of consideration for the moment the angular notch, the resilience increases, for non-brittle metals, when the depth of the notch diminishes; it even doubles, with highly resilient steels, when we pass from a notch of mid-thickness to one of only 1 mm. in depth. With brittle metals the resilience varies very little with variations in the depth of the notch. With an angular notch on the other hand non-brittle metals yield results analogous with those obtained with a deeper round notch; for brittle metals the results are lower. These results emphasise the importance of an exact definition of the notch in classifying metals in the scale of resiliences.

Influence of Size of Test-Bars.—It would obviously be desirable to adopt a single standard test-bar for the study of metals under shock, but in practice the use of several types of test-bars of different sizes cannot be avoided. It is necessary, under such conditions, to investigate whether, for a given metal, any simple relationship exists between the resiliences as determined on test-bars of different shapes. It had been thought, at the outset, that in order to obtain comparative results it would suffice to employ notched test-pieces of geometrically similar shapes, but the tests carried out by the authors, as described in this Paper, show that the resilience, even in the same metal, varies to a considerable extent according to whether it be determined on test-bars measuring 30 × 30 × 160 mm. or on test-bars 10 × 10 × 53.3 mm. Whether the metal be steel or copper, the resilience increases with the size of the test-bars. The ratio between the results itself undergoes modification, rising from $\frac{4}{3}$ for the least brittle steel to $\frac{3}{2}$ for the most brittle, and to $\frac{5}{3}$ for copper. This fact has been previously noted by many observers of various nationalities. A theoretical investigation published in 1911 by Captain Mimey concludes, from the point of view now under discussion, that the deformation of the test-bars B_1 and B_2, whether notched or not, and geometrically similar according to the similitude relation *a* will absorb T_1 and T_2 energy which will be to each other as the cube of the homologue dimensions, if the tups M_1 and M_2 of the drop-testing machines, the heights of fall H_1 and H_2 and the distances between supports D_1 and D_2 comply respectively with the conditions:—

$$\frac{M_1}{M_2} = \frac{\sqrt{H_1}}{\sqrt{H_2}} = \frac{D_1}{D_2} = a.$$

This is therefore the ratio sought between the resiliences R_1 and R_2. Unfortunately the author's experiments appear to indicate that this ratio does not conform in a satisfactory manner to the conditions in practice. It has been brought out, in the course of this Paper, that the work absorbed by the fracture of a test-bar is independent both of the mass of falling weight and of the height of fall, or in other words that the kinetic energy absorbed was practically independent of the kinetic energy available, and of the rate of speed of the weight at the moment of impact. The supplementary conditions introduced by Captain Mimey are

insufficient therefore, *a priori*, to secure the comparability of the resiliences obtained on two similar test-pieces. The authors have verified this on many occasions. They confine themselves, in the present instance, to giving the results of two sets of tests made, one on copper, the other on the special steel P. These tests established clearly:—(1) That the internal homogeneity of the metal was satisfactory; (2) that the resiliences given by the test-bars of 10 × 10 mm. differ distinctly from the resiliences given by the test-bars of 30 × 30 mm. It is therefore justifiable to state that the law of similitude does not apply in the case of shock tests on notched bars. Captain Mimey's conclusions are, however, applicable when a deformation is produced by shock—without proceeding as far as fracture—in bend tests on bars without notches.

British Foundrymen's Association.

Scottish Branch.

The first meeting of the 1917-1918 session of the Scottish Branch of the British Foundrymen's Association was held at Glasgow on October 13. Mr. Matthew Riddell, the President, occupied the chair. Mr. Riddell, in the course of his remarks, referred to the syllabus of lectures for the session, which is as follows:—November 17, Electric Cranes," by Mr. A. Weddell; December 8, "Cupola Notes," by Mr. R. R. McGowan; January 12, "Cast Iron from an Engineer's Standpoint," by Professor A. L. Mellanby, D.Sc., M.I.Mech.E.; February 3, "Carbon in Cast Iron," by Mr. C. H. Desch, Ph.D., D.Sc.; March 2, "Special Irons," by Mr. J. Donaldson, B.Sc.; March 23, "A Government Information Bureau for Foundrymen," by Mr. R. Buchanan, F.R.S.A.

The chairman drew attention to the Branch programme, which was again issued in book form, with several new features added, such as the addresses of all the ironfounders in Scotland, definitions and data relating to cupola practice, and a glossary of technical terms.

Mr. Riddell then delivered an address on "The Interpretation of an Analysis." At the outset he explained that the reason which led him to take up the consideration of this subject was the fact that certain conditions were being imposed on much of the work which was at present being produced throughout the country, and these conditions were causing a considerable amount of trouble and some irritation.

A great deal of the present trouble arose from the nature of the tests demanded. In most of the work two tests were imposed, one physical and one chemical. Where the castings would be subjected in use to shock and heat he agreed that the two tests referred to were quite legitimately demanded; what the founder objected to, however, was the double test being enforced when the work was only subjected to one or other of these actions.

Where castings were subjected to shock only, the physical test only was essential, and the founder should be left to produce an iron to fulfil this physical test irrespective of the chemical analysis; or in the case of castings, such as acid pans, where strength was not the essential factor, a chemical test only was essential.

The lecturer, in conclusion, traced the influence which the various constituents in iron had on the strength of the casting, and how an increase or decrease in these constituents altered its structure.

Newcastle Branch.

At the annual meeting of the Newcastle and district Branch of the British Foundrymen's Association, held on September 29, 1917, Mr. W. J. Paulin (the retiring President) in the chair, the annual report, which was briefly noted in our last issue, was adopted. The election of officers was as follows:—President, Mr. W. Mathews; Senior Vice-President, Mr. J. Carmichael; Junior Vice-President, Mr. Edward Smith; Hon. Secretary, Mr. H. A. Rang; Delegates to General Council, Messrs. Edward Smith and E. Tait.

Before vacating the chair, the retiring president thanked all the members for the splendid manner in which they had supported him during his year of office. The whole year's work had been a great delight to him, and he had had the opportunity, which, perhaps, was one to which every engineer should look to with pleasure, of getting to know from the foundrymen themselves the inner knowledge of the work, which an engineer was never supposed to understand. Thus the engineer gained a knowledge which enabled him to criticise their work with greater authority and weight, and if that sort of thing tended to the production of better work on the part of moulders, then it was all to the good of their profession.

Mr. R. Wallis, the first president of the Branch, moved a vote of thanks to the retiring president, and remarked that the work done during the year showed considerable progress in the advancement of the art of the foundryman.

The presidential address subsequently delivered by Mr. Mathews is dealt with on another page.

London Branch.

The first meeting of the session was held on October 4, when Mr. T. W. Aitken delivered his presidential address, and also presented a paper on "Melting Furnaces." These will be dealt with in our next issue.

Raw Materials after the War.

Dr. Addison, the Minister of Reconstruction, after consultation with the other Government Departments concerned, has appointed a Committee to consider and report upon questions connected with the supplies of raw materials which will be required by British industries for the purpose of restoring and developing trade after the termination of the war and the best means of securing and distributing supplies, due regard being had to the interests of the Allies.

The Committee is requested, in regard to any commodities which might not be available in sufficient quantities and at reasonable prices through the ordinary commercial channels, to consult members of the trades concerned with regard to any steps that may be necessary to safeguard the needs of industry and to secure convenient and equitable distribution.

The Committee, which will be known as the Central Committee on Supplies of Materials, consists of the following: Sir Clarendon Hyde (chairman), Sir Henry Birchenough, K.C.M.G., Mr. Cecil Budd, Sir Charles W. Fielding, K.B.E., Sir H. Babington Smith, K.C.B., Mr. Wallace Thorneycroft, and Mr. Andrew Weir.

The Secretary is Mr. J. F. Ronca (Board of Trade), communications to whom should be addressed at the Ministry of Reconstruction, 2, Queen Anne's Gate Buildings, Westminster, S.W.1.

Refractories.

Last month a meeting of the Refractory Materials Section of the Ceramic Society was held at Glasgow, under the presidency of Mr. W. J. Jones (Ministry of Munitions) at which a number of Papers were read, most of them bearing on the properties and uses of refractory materials. We append abstracts of three of the Papers :—

TESTING REFRACTORY MATERIALS.

I.—THE REFRACTORY TEST.

By Dr. J. W. Mellor (Clay and Pottery Laboratory, Stoke-on-Trent).

The ultimate object in testing a firebrick is to determine how it is likely to behave when in use. In devising the tests it is, of course, desirable to reproduce as nearly as possible actual working conditions. A service trial accompanied by records of the furnace conditions is the ultimate test of the quality of the material, and this may be regarded as the ideal mode of testing. Unfortunately, such tests would occupy far too long a time to be a useful criterion of the quality of any particular consignment of refractories. Further, contradictory reports are obtained even with service trials. Of course, a very slight change in the design of a furnace may make all the difference between success and failure. For instance, the writer has known half-an-inch difference in the position of the tuyere-nozzles of a cupola to alter the life of the lining from a few days to as many weeks. It is also found that when tests are made on a small scale, different results are obtained; and when tests are made in the laboratories of user and consumer, under different conditions, the results are not always concordant. Even to-day there are troubles in several trades on account of discordant analyses. It is therefore important that the methods of conducting the tests be standardised, since a consignment might be condemned on a set of tests conducted in one laboratory which would pass the tests satisfactorily if conducted in another laboratory.

The fire stability of a refractory is perhaps its most important quality, and one of the most important properties indicating the fire stability of a refractory is the squatting temperature. It is very important to have a clear idea of what is meant by what is variously called the fusing temperature, softening temperature, squatting temperature, fire stability and the melting or fusion point of a refractory.

Importance of Specifying the Rate of Rise of Temperature.—When the temperature of a fireclay or firebrick is gradually raised, the material—more particularly aluminous firebricks—behaves in a manner almost analogous with pitch or butter. It becomes less and less viscous, ultimately the viscosity is so reduced that the material is no longer able to retain its shape, the angular corners and edges are rounded, and the material begins to flow. There is no precise or definite temperature above which it can be said that the material is a flowing liquid, and below which it is a rigid solid. The softening temperature of a firebrick is not, therefore, a definite temperature, but rather a range of temperature within which the substance begins to lose its shape and commences to flow. Observation shows that this range of temperature is wider with aluminous firebricks than it is with siliceous firebricks. If the temperature be rapidly raised, the material appears to soften at a higher temperature than if slowly heated, because the internal forces have not time to attain a state of equilibrium before the material is carried to a still higher temperature. Otherwise expressed, the actual squatting of the material lags behind the temperature, and the faster the rise of temperature the greater the lag. The effect is sometimes very pronounced. For instance, two different firebricks with a difference of 150 deg. in their squatting temperature on a slowly rising temperature, appear to be equally refractory on a rapidly rising temperature. The softening temperature of a refractory for one rate of rise of temperature does not correspond with the softening temperature determined for another rate of rise of temperature. Consequently, the rate of rise of temperature must be standardised if refractory tests are to be compared one with another.

Definite Temperatures versus Seger Cones.—Is it better to express the softening of a refractory as a definite temperature determined by means of a pyrometer or in terms of suitable cones? In the present state of our knowledge, the answer must be given in favour of cones. It must be remembered that we are dealing with a range of temperature, not a specific temperature. Whatever be the nature of the reactions which are attended by the fusion of the refractory, it is assumed that the temperature coefficient of the reaction in the Seger cone and clay are the same. The assumption is based on more or less remote analogy between the cone and the clay.

The Size of the Test-Piece.—Would the refractory test be improved by using larger pieces—say a whole brick? The writer does not think so. There are difficulties, but not insuperable ones, in maintaining a whole brick at a uniform temperature throughout the mass, and also in estimating the temperature of the interior of a hot brick. The fusion of a brick always commences at the surface, not necessarily because on a rising temperature the surface must be slightly hotter than the interior, since by raising the temperature slowly enough the difference of temperature could be made negligibly small. The phenomenon is an effect of surface tension, and the surface of a firebrick of uniform composition uniformly heated must be the first to show signs of fusion.

Oxidising versus Reducing Atmospheres.—It is well known that if a refractory material contains much iron its refractory test gives a lower result if conducted in a reducing atmosphere than if conducted in an oxidising atmosphere. The bricks are usually fired in an oxidising atmosphere, and very frequently used in a reducing atmosphere. The test naturally should be conducted under reducing conditions, and it is perhaps easier to make the test under such conditions than in an oxidising or neutral atmosphere. The only objection to the reducing atmosphere depends on the fact that the reduction of the iron sometimes takes a long time, and it is then difficult to get constant and comparable results. A different proportion of the iron is reduced in the different cases.

Testing Refractories under Load.—There is a difficulty in standardising the test for refractories under load. With the more aluminous types of refractory there is a rapid fall in the squatting temperature as the load increases. To get com-

parable results from test to test, for industrial purposes, it is necessary either to fix an arbitrary pressure at which the tests shall be made, or else to express the results in the form of a curve. The latter is probably the better way, although it will probably be more convenient to conventionally specify a definite load—say 30 to 50 lbs. per sq. in. With aluminous refractories there does not appear to be a limit to the decrease in the refractoriness under an increasing load.

The Manufacture of Firebricks without Kiln-Firing.—The logical inference from these facts is somewhat startling; it is merely necessary to drive the water from clays, and then mould the bricks under a great enough pressure to perform the work of vitrification without firing the bricks at all. The writer has taken some trouble in the past to emphasise the fact that the vitrification changes which occur during firing are arrested by the manufacturer at a certain stage of their progress, and that a number of firings at, say, cone 4, under normal conditions, will do the work effected by one firing at cone 10. When no undue pressure is exerted, however, the reaction is arrested if the temperature be reduced much below cone 4, and no vitrification occurs. At first sight any proposal to manufacture good firebricks without kiln-firing seems to border on madness. We have become so obsessed with the idea that manufacturers of firebricks do not fire their products to a high enough temperature, that a counter proposal, say, to compress the dehydrated clays in a freezing chamber without firing appears the rankest heresy, not to be taken seriously. In spite of this, the writer sees no flaw in the deduction when applied to aluminous clays. In practice, however, things have a way of developing differently from what logic prescribes, because we are so liable to overlook some essential factor. In the present case, the unforeseen difficulties will have to be furnished by observation and experiment.

The concluding portion of the Paper was devoted to some theoretical considerations of the subject.

REFRACTORIES AND MODERN KILNS.

By J. G. Maxwell.

Before discussing the various types of kilns suitable for burning firebricks and fireclay blocks, it would be as well to look into the various types of fuel available in this country for the purpose of firing such kilns. These are:—(1) Town gas; (2) oil; (3) producer gas; (4) coal; (5) peat and lignite (gasified). We may at once dismiss town gas and oil as impracticable propositions in this country. Consequently the two fuels that we have available for firing high-temperature kilns in this country are producer gas and coal. Peat and lignite require to be gasified to be used with proper effect, for owing to the 40 per cent. to 50 per cent. water in an air-dried sample of the former it is not suited for use direct in a firehole.

The advantages of firing with producer gas as against coal are:—(1) Temperature under complete control; (2) high temperatures obtained more economically and speedily than with coal, and any given temperature reached is more easily held in the kiln than with coal, and with comparatively no fluctuation; (3) great cleanliness of burning if provided with adequate supply of air; (4) great saving on wear and tear of kiln.

Having pointed out the main advantages of gas-firing over coal-firing, we shall assume that the types of kilns which we describe are gas-fired, though it is quite possible to fire each type with coal. The three best-known types of kilns for refractory goods are:—(1) The continuous annular shape gas-fired kiln; (2) the continuous annular shape chamber type gas-fired kiln; (3) the continuous tunnel and car kiln.

The ordinary gas-fired continuous kiln presents certain disadvantages which cannot in everyday working be entirely overcome. In the first place, the air required for the combustion of the gas passes through the open wicket and then passes through chambers containing bricks which are cooling off, and in doing so becomes pre-heated, and thus the air is brought to the gas candles (the removable perforated fireclay pipes stacked vertically) in a highly heated condition by regeneration. The amount of air, however, that enters these wicketways is under no control at all, and is, of course, often a great deal more than is necessary for the complete combustion of the gas. It is generally reckoned, speaking roughly, that five times as much air is supplied to the gas candles as is theoretically necessary for complete combustion. Assuming for a moment there were seven rows of candles across the chamber firing at the same time, the first row would receive a good deal more air than was necessary for complete combustion, the row behind a supply of air in diminished quantity, till probably the last two or three rows would receive insufficient air for complete combustion, for it is obvious that there is no practical means of regulating this air supply. If just sufficient air was admitted through the open wicketways of the kiln to supply enough air for complete combustion to the first row, the gas burners of the second and following rows would obviously not receive sufficient. Further, the air required for combustion, entering by the wicketways, in passing through the chambers of cooling bricks becomes highly heated, and consequently specifically lighter than the heavy gas. This gas enters from the floor of the furnace, and consequently there cannot be the ideal mixture of gas and air so essential for perfect combustion. In spite of these and other imperfections, this type of kiln is a really good one, and is undoubtedly the cheapest and most simple type to erect; it is easy to set and draw and operate.

The chamber type kiln is capable of reaching very high temperatures, and of giving prolonged soakage to refractory goods; it has been employed with the greatest success for burning carbon electrodes, and also for burning magnesite and silica bricks and very high-grade firebricks. As compared with the open-tunnel type of gas-fired kiln, this chamber type form offers a number of advantages, although it is generally assumed that the chamber type is not so economical in fuel consumption as the ordinary continuous kiln. This is undoubtedly true, as the extra walls absorb a great deal of heat, but the regulation of the air supply and the gas being under such complete control in the chamber type kiln, the economy effected in producing a perfect admixture of gas more than counterbalances this. A number of other advantages follow from this complete control of the gas and air supply, and the perfect admixture of the air and gas before becoming ignited which do not exist in the ordinary continuous kiln. The chamber type kiln is capable of reaching considerably higher temperatures than the ordinary gas-fired kiln, one reason for this being that the enclosed chamber retains its heat much longer than the ordinary open type, and

consequently the air for the combustion of the gas is supplied very much hotter to the gas, and also at a more constant heat.

The following disadvantages apply to both of the kilns described. Owing to the length of the kilns the gas from the fixed producer has to travel a considerable distance to reach the far chambers of the kiln, and it is not practical to have the main gas flue from the producer built in the kiln itself where it might be kept warm. Owing to the danger of possible leakages through the expansion and contraction of the kiln, the main gas flue in the best type of gas-fired continuous kiln is constructed outside the kiln, and in such a flue it is quite possible that the gas may lose as much as 50 deg. to 75 deg. C. per metre run. Far greater heat losses, however, occur from the constant heating up and cooling off of the walls of the kiln.

The type of kiln which will probably be the kiln of the future for most kinds of high-class refractory ware is the gas-fired continuous tunnel and car kiln. Roughly speaking, it consists of a long tunnel which is theoretically divided into three parts: (1) the preparatory or entrance zone; (2) the actual firing zone, and (3) the cooling off or departure zone. The fuel economy obtained places these gas-fired tunnel and car kilns as far ahead of other continuous kilns as they are ahead of the intermittent type, and their output is very large.

REFRACTORY PROPERTIES OF SILICA.

By H. Le Chatelier and B. Bogitch.

The use of silica bricks in the construction of furnaces has alone permitted the generalisation of firing with the regeneration of heat. Up to now, however, the superiority of silica over clay has not been explained in any certain manner. Recent experiments concerning the refractory properties of clay allow the authors to offer a very precise explanation. The clay bricks begin to soften between 1,300 deg and 1,400 deg. They cannot, therefore, sustain important efforts without giving way in a continuous and indefinite manner. And this occurs more rapidly as the temperature is higher—that is to say, they act like a vitreous substance; they have no real fusing point, but only an extensive fusibility range.

In order to explain the different way in which clay and quartz act, one could suppose that the latter has, on the contrary, a real point of fusion, without previous softening, and consequently independent of pressure. The authors' experiments have fully confirmed this conclusion. The following table gives a summary of the results of the authors' experiments on a good silica brick of American make. The resistances to crushing are expressed in kilogs. per cm²:—

Temperature. Degs.	Resistance to crushing.	Temperature. Degs.	Resistance to crushing.
15 ...	170	1,200 ...	85
520 ...	158	1,320 ...	62
670 ...	150	1,460 ...	50
800 ...	139	1,540 ...	37
950 ...	125	1,600 ...	30
1,050 ...	120		

These figures lead by extrapolation to a resistance of 12 kilogs. at 1,700 deg., the usual temperature of the arches in steel furnaces. This resistance corresponds to about 10 times the effort sustained by the bricks in the arches. Consequently, the stability of the latter is assured. This mechanical resistance, being retained up to very high temperatures, is a special peculiarity of silica bricks. It is not found in clay bricks, nor even in bricks whose essential constituent is magnesia, which is much less fusible still than silica. The reason of these differences is that in both cases the bricks contain basic oxides foreign to the principal refractory material, and which produce in all cases a fusible matter already liquid at about 1,200 deg. In the case of magnesia the solid grains float in the melted magma and slip easily one over another as wet sand would do. Silica, on the contrary, at least in well-burnt bricks, forms a continuous network, in the pores of which the melted mass lodges, like water lodges in the pores of pumice-stone without diminishing the mechanical resistance.

When a good silica brick is heated, its resistance diminishes with rise of temperature. The reason of this is that the solubility of silica, increasing with the temperature, a progressive dissolution of the crystalline network is produced and tends to disintegrate it and even to dislocate it entirely. This effect is the more delayed as the network is better developed. It is on this that the quality of silica bricks depends before anything else. The researches of which the authors give an account had for their object the solution of this problem. The principal factors to take into consideration are:—(1) The proportion of fluxes; (2) the actual temperature of the brick; (3) the good formation of the network; (4) the disintegration of the network through subsequent swelling out.

Proportion of Fluxes.—Good silica bricks contain between 3 and 5 per cent. of basic oxides, and the weight of sulphates varies from 8 to 14 per cent. The relation between the weight of the oxides and those of the sulphates varies necessarily according to the nature of the bases, but, as their relative proportions remain generally confined between fairly close limits, it can be said that the weights of the oxides represent a practically constant fraction of the weights of the sulphates, on an average 35 per cent.

Temperature.—The temperature which the brick supports depends entirely on the use one wishes to make of it. In steel furnaces it must bear a temperature of 1,700 deg. Silica bricks are also used in ovens for the distillation of coal, in which the temperature is not so high. A proportion at least double of the basic oxides can be used without inconvenience for this purpose, and thus the manufacture is made much easier.

Constitution of the Network.—In order to develop the network the brick must be kept for a very long time at such a high temperature that the melted magma may be sufficiently fluid. Experience seems to indicate, as the most favourable conditions, several days' firing at a temperature approaching 1,450 deg. This temperature must be inferior to that at which the quartz used is directly and rapidly transformed into cristobalite.

Disintegration of the Network.—When, after firing, grains of quartz remain not transformed, if the brick is afterwards abruptly heated to a temperature at which quartz is rapidly transformed, the expansion which accompanies this transformation shatters the network and robs the brick of all solidity. Moreover, the pressure to which it is submitted in the arch resists its lateral expansion and produces the phenomenon of spalling; thus it falls in small fragments, causing sometimes, in a few days, the destruction of an arch which should have lasted months. All good bricks possess at 1,600 deg., after heating for an hour, a resistance to crushing at least equal to 10 kilogs. per cm.² The prolongation of heating, at this temperature, diminishes their resistance little in opposition to what happens with bad bricks.

The Use of Metric Iron by Primitive Man.

By George Frederick Zimmer.

In endeavouring to establish the evidence in favour of the use of meteoric iron by man, the author is aware that he is opposing the opinion of men of learning who may have forgotten more than he ever knew, but none the less he hopes that the information which he has collected with great trouble and care will be accepted as proof that the use of such iron in early times is a fact. He also gives expression to the hope that those members of the Iron and Steel Institute who have made a study of the antiquity of iron, and particularly Sir Robert Hadfield—who is an acknowledged authority on this subject—will take a kindly interest in this account of the very earliest history of iron, and that it may be accepted as a link in the chain of evidence upon which that history is based.

Professor Flinders Petrie, in a Paper on "The Metals in Egypt," states that iron was not intelligently produced by an understood process as a regular manufacture before 1200 B.C. This the author has no means of verifying, but it must have been produced from the ore more or less accidentally long before that date, and the supply of iron obtained in that way and from other sporadic sources doubtless accumulated in the early millenniums to a comparatively considerable amount. This store of iron was not allowed to diminish, except by wear and tear of the objects by use, such objects being handed on from generation to generation; and, according to Maspero, if they became obsolete in form they were reforged; they were much too valuable to be buried with the dead, and not likely to be left behind by careless owners; hence its scarcity in museums.

Professor Flinders Petrie states further in the same Paper that the sporadic sources of iron must have been either native iron or else casual production by accident. The learned professor adds that meteoric iron could not have been used, as it was not malleable. This latter assertion is based on a misunderstanding, accepted also by Professor Thorp in a Paper read before the Royal Philosophical Society of Glasgow in 1872.

It is much more likely that, in addition to iron produced accidentally from the ore, meteoric iron (not telluric) was used, for whereas tons of meteoric iron are exposed in the cabinets of our museums, the specimens of telluric iron (if we accept the dubious find on the west coast of Greenland) in our own national collection can be held in the hollow of one hand; there might be enough for a few beads, but not for larger objects.

Professor William Gowland, in a lecture on "The Metals of Antiquity," agrees rightly that meteoric iron is malleable, but urges its rare occurrence and the impossibility of detaching pieces suitable for working from almost all meteorites by means of stone or bronze tools. He goes on to say that the assumption that these forms of iron (telluric and meteoric) must have been the earliest source of metal is not only without any solid foundation, but is totally unnecessary, because iron ores are so easily reducible that they can be converted into metallic iron in an ordinary wood or charcoal fire. St. John V. Day in "The Prehistoric Use of Iron and Steel," Dr. L. Beck in "Geschichte des Eisens," and Bennett H. Brough more or less share the same opinion.

Let us first see in how far the above is undeniable. A compact mass of meteoric iron as it exists in the mind of the uninitiated can hardly be severed, but from the more ramified, straggly, or protuberant masses pieces have undoubtedly been detached (such as for the Eskimo knives), and this subject will be further discussed later. The ease with which iron ore can be reduced is also beyond dispute, but, as Professor Flinders Petrie says, this method (in spite of its ease) was not used or regularly understood and iron manufactured before 1200 B.C. Civilisation, as far as the use of such metals as copper and iron goes, is however, several thousand years older, and after 1200 B.C. few would perhaps trouble, in those parts where iron was manufactured, to use meteoric iron. Meteorites, or rather siderites and siderolites, are found in all sizes, weighing from a few ounces to masses of 50 tons, and some of the smaller ones were undoubtedly wrought into objects according to their size.

We can best illustrate the condition in antiquity by citing a parallel, often resorted to, between more primitive people and those of antiquity. Travellers have frequently found iron implements in use by a people who have never communicated with the

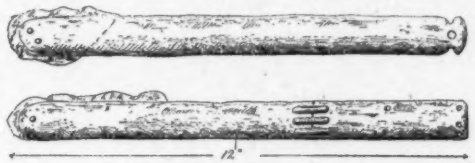


FIG. 1.—ESKIMO KNIVES FOUND BY CAPT. J. ROSS AT CAPE YORK, WEST GREENLAND, AND NOW IN THE BRITISH MUSEUM (SOUTH KENSINGTON).

outer world by barter or otherwise, and who were absolutely ignorant of even the crudest form of iron production from the ore, and in whose locality, moreover, iron ore is not found. Such implements must of necessity have been produced from telluric or meteoric iron. Thus when in 1721 Hans Egede found the Eskimos using arrows, spears, etc., with bone and stone points, he also found occasionally iron points on such implements. Similar conditions were found when S. Hearne in 1772 visited an Eskimo tribe on the Coppermine River. He found them using principally weapons and implements of native copper, but also a few which were evidently of meteoric iron. He mentions two pieces, one 1⅛ in. by 3½ in. converted into a knife as used by a woman (known as "Oodoo"), and the other 1 in. by 2¾ in., which was mounted on a piece of walrus tusk and used as a man's knife ("Savik"), and known in the Hudson's Bay under the name "Mokeatoggan." Likewise do we learn from Sabine, who accompanied the explorer Captain John Ross in 1818, that the Eskimos of Cape York in Baffin Bay, on the west coast of Greenland, employed meteoric iron in a similar way, for the members of the expedition were attracted by the knives they used. He tells us that every one of the Eskimos who visited them on August 10, 1818, and afterwards, carried an implement with an iron edge which was used as a knife. The

handle was 9 to 11 in. long, of flat bone, and the cutting edge was formed by a series of from three to seven flattened flakes of iron inserted into a groove in this bone, extending to about half its length. These iron flakes, some not larger than a threepenny piece, were not riveted in position, except that forming the point. Fig. 1 illustrates two of these knives now in the British Museum (South Kensington), and similar knives

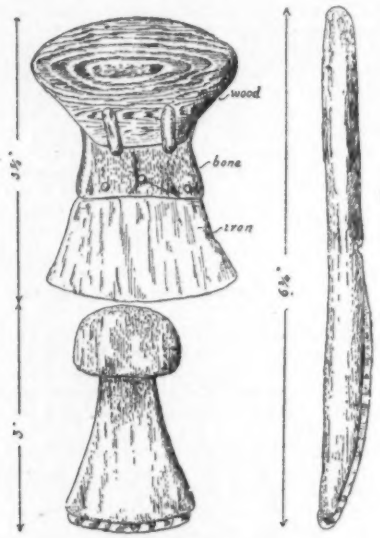


FIG. 2.—ESKIMO IMPLEMENTS OF METEORIC IRON, COLLECTED BY J. STEENSTRUP.

are shown in the museums of Vienna and Göttingen, etc. They have been analysed by Wellaston and proved to be of meteoric iron. It transpired that the source of the iron was the three masses of the Melville Bay meteorite, and that the pieces detached were beaten flat between stones without heat. One of the masses, known as "The Woman," was softer than the other two, and was therefore almost exclusively used. It is estimated that nearly one-half of the original mass has been detached by the Eskimos through many generations, about 12 cub. ft. being left.

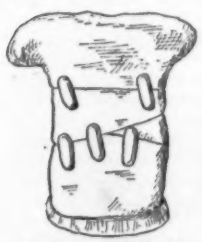


FIG 3. — "OODOO" OR WOMAN'S KNIFE MADE FROM THE MELVILLE BAY METEORITE HANDLE OF IVORY

Similar instruments were described by J. Steenstrup at the Congrès International d'Anthropologie et d'Archéologie Préhistoriques à Bruxelles (Session de 1872). He examined more than twenty of these implements, and gives drawings of some of them. Fig. 2 shows sketches reproduced from these. Figs. 3 and 4 are similar implements described by Robert E. Peary in "Northwards over the Great Ice."

F. Johnstrup, Professor of Mineralogy at the University of Copenhagen, determined the presence of about 3 per cent. of nickel in these irons, and found that they distinctly exhibited Widmannstätten figures. He believes that the metal has not been subjected to the action of heat.

Dr. I. J. Hayes, the Arctic explorer, in a letter to Professor Shephard, speaks of a flake of meteoric iron which he obtained at Port Foulke in 1861 from an Eskimo, who had carefully preserved it and other fragments to make (with a bone blade) the edge of a knife. The iron, it was stated, had been detached by means of flints, and was obtained from a place called Savisavik (*savik*=knife), twenty miles S. and E. of Cape York, Northern Greenland, in lat. 76°. This does not appear to be the same source of metal as that described in Ross's "Voyage to Baffin's Bay," 1819, p. 105, as Sowallick (iron mountain), between Cape Melville and Cape York (lat. 76° 12′ N., long. 65° 53′ W.), which is N.W. of the latter Cape.

Clavering and Sabine met, in 1823, in the northern part of Eastern Greenland, a small tribe of Eskimos, now extinct, who had never seen a white man, and who had no dealings or intercourse with those dwelling on the western coast, but they had among their bone-pointed spears and harpoons some with iron points of undoubted meteoric origin.

The Eskimos' method of using the meteoric iron was precisely the same as one might expect a

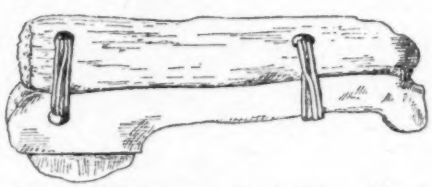


FIG. 4.—"SAVIK" OR MAN'S KNIFE (ACTUAL LENGTH 4 IN.) MADE FROM THE MELVILLE BAY METEORITE. HANDLE OF WOOD AND BONE.

Stone Age people to employ, *i.e.*, by grinding it into shape and attaching it to wooden or bone hafts with withes or raw hide, except that a little hammering appears to have been used, exactly as the Indian tribes which dwelt further south used the native copper.

Sir John Lubbock (in his "Prehistoric Times," 1890) informs us that, "At the time of the discovery of America, iron (manufactured) was absolutely unknown to the natives, with the exception, perhaps, of a tribe near the mouth of the La Plata, who had arrows tipped with this metal, which they are supposed to have obtained from masses of native iron." This can only be meteoric iron used in a similar way to that in which the Eskimos used it. Sir John does not give any reference concerning this: it is probably from Amerigo Vespucci, who says definitely that in the fifteenth century the Indians at the mouth of the La Plata were in the habit of making arrow-heads and other implements of meteoric iron.

Another exception to the above should be that mentioned by Acosta, who found wedge-shaped pieces of iron (*cuños de hierro*) which circulated as currency in Paraguay. The shape of these commodities would indicate that they were used by their owners as implements and weapons when not in circulation as currency.

Into this latter category may also belong the bars of iron used in the time of Lycurgus (the Law-

giver) by the Spartans as money.* Both examples show that the commonest terrestrial metal was in early times very precious, because sporadic and rare, and most probably in both cases of meteoric origin; for if the lump of iron offered by Achilles as a valuable prize at the funeral games of Patroclus (33rd book of the "Iliad") was of meteoric† origin, it is not unlikely that the Spartans only a few hundred years later should depend upon that same source for a currency which could be used as a tool and a weapon as well.

Dr. H. Hensoldt tells us in "Meteorites and what they Teach Us" that when Cortez had completed the conquest of Mexico, the Spaniards, among a great many other peculiar and extraordinary observations which they made in that remarkable country, were particularly struck and puzzled by one fact. They noticed that the Aztecs possessed certain implements, such as knives, daggers, etc., made of iron, but it seemed that only the most distinguished of the natives possessed such, that iron was a great rarity and was prized higher than gold. At first the Spaniards believed that the Aztecs extracted the metal in some crude fashion from its ore, which abounds in many parts of the country, but they soon ascertained that this was not the case. They found that not a single smelting furnace existed in the empire, and their surprise was not small when they learned that the Aztecs were totally unacquainted with any method of extracting the iron from the ore, which, indeed, they had never suspected of any kinship with the highly valued metal.

The question whence the Aztecs had procured the little iron they possessed became a perplexing problem to the Spaniards, which they were never able to solve. The natives do not seem to have enlightened them much on the subject, for when asked they mysteriously pointed to the sky, and indicated that they obtained their iron from the regions above. Such assertions, no doubt, the Spaniards received with an incredulous smile, and they concluded that the Aztecs procured it by way of traffic from some other, perhaps more civilised, nation which they suspected to exist and kept looking for north and south for more than a hundred years.

It was left to modern science to unravel the mystery. The Aztecs were quite correct; the iron of which they had made their implements was not fashioned from materials of this terrestrial globe, but had come to them from the unknown regions of space. Their iron was, in fact, of meteoric origin, like that of the Mayas of Yucatan and the Incas of Peru, of which many weapons are still preserved in collections.

We will now see what has actually been achieved by the ancients in this direction. Quite *en passant* it may be mentioned from ancient mythology that the victorious Attila, Timur, the celebrated Arab Antar, and other heroes claimed the use of swords fallen from heaven, which sounds significant of meteoric iron. The swords of the Caliphs, the subject of ancient Arab songs, come under the same category, and the celebrated Orientalist Hammer von Purgstall believes that the early Damascus blades were of the same material. The peculiar pattern on these blades would be the Widmannstätten figures distorted by the operation of the smith. Professor Gustavus Hinrichs in "A Celestial Messenger" says: "The many stories of invincible or irresistible swords, sometimes said to have come from heaven, have reference to weapons made of meteoric iron." In the Turner and Liberty groups of mounds in the Little Miami Valley, South-Western Ohio, altars or basins of burnt clay were found by Professor F. W. Putnam literally full of objects of interest, including spool-shaped copper ornaments, some overlaid with meteoric iron and some with silver, as well as a celt 5 in. long, ear-rings, and other ornaments entirely of nickeliferous meteoric iron, also a folded and corrugated band of iron. Some of the masses of meteoric iron have been more or less hammered into bars, as for the purpose of making some ornament or implement, and others are apparently in the natural shape in which they were found. Similar ornaments have been found in the Hopewell Mounds, Ohio. It is believed that these ornaments, etc., which included pieces weighing 767.5 grammes (27½ oz.), have most likely been wrought from the Brenham (Anderson) or Brenham Township irons and from the Eagle Station iron, or possibly also from the Descubridora iron, which when found showed an abortive attempt made by a neolithic people to sever it.

The celebrated Arab philosopher Averrhoes mentions a meteoric iron which fell near Cordova in Spain, weighing 100 lbs., which has been wrought into excellent swords. A dagger found by Dr. Schliemann at Hissarlik, the site of Troy, among a lot of stone weapons and obsidian knives is, in his opinion, of meteoric iron; indeed, it must be nickeliferous iron on account of having retained its brightness to this day.

P. Orsi, in his excavations in Sicily about 1909, and while investigating the graves of the Cava della Signora near Castelluccio, near Noto, found in the oldest part of that necropolis, in Grave No. 23, two amber beads and half an iron finger-ring. Orsi assigns these graves to the transition period of the Stone to the Metal Age, which he names the first Siculian period, which is of the same cultural advance as the lowest strata of Hissarlik and therefore prior to Mycenæan culture. Owing to the smallness of the iron object Orsi would not sacrifice any portion of it for chemical analysis, but there is little doubt that it was wrought of meteoric iron.

The following table gives more recent examples of the use of meteoric iron by more or less primitive man, which will prove that it is both malleable and could be severed by such people:—

Name of meteorite.	Date of fall or find.	Remarks.
Bendego River ..	1784	A wrought specimen is in the Göttingen collection. A local blacksmith has severed all projecting portions for use. (Buchner.)
Bethany	1853	Wrought by the Namaquas into arrow- and assagai-heads (Cohn, III. 329.) The iron is so ductile that they work it cold into rifle bullets. (See Krupp's experiment.)
Billings	1903	A horseshoe nail has been worked from a fragment.
Bitburg	1802	Over a ton has been used by local blacksmiths.

* The reason for this introduction was supposed by Plutarch who lived over a thousand years later, to be that the Spartans should not carry much of this heavy money about with them. In reality it is believed that a few centuries after, when iron became common everywhere, no explanation for this early currency could be found. It was forgotten that iron was once hardly known and the most precious of metals, and for the want of a better explanation the legend was invented.

† Liddell and Scott translate "rudely cast," but from Sir John Herschel's correspondence with Professor von Haidinger it should read "self-fused" or "native iron."

Name of meteorite.	Date of fall or find.	Remarks.
Brenham	1883	A celt, head and ear and other ornaments have been wrought from this iron by a neolithic people.
Burlington	1819	62 kilogrammes used by local blacksmiths; only 6 kilogrammes now left in collections. (Beck, "Arch. of Anthropology," 1880.)
Cape of Good Hope..	1793	Forged by the Boers into agricultural implements. Capt. Sowerby had a sword made 24 in. long by 1¼ in. wide, welded into a steel haft, mounted and presented to Alexander I. of Russia. (Donkelmann, *Annales de Chimie et de Physique*, Paris, 1820, vol. 8, p. 111.)
Chesterville	1849	About one-half the mass (8 kilogrammes) wrought into door hinges and horseshoe nails.
Chulafinnee	1873	Wrought into a ploughshare and horseshoe nails. (B. Sillman and Hidden, *Am. Jour. Sc.* (III.), vol. 18.)
Cocke County ..	1837	Forged into a gun barrel and "gunscalps"; is as bright as silver. (Shepard and G. Troost, *Am. Jour. Sc.*, 1870.)
Cranbourne	1854	Mr E. Fitzgibbons, secretary of the Municipality of Melbourne, succeeded in removing enough of the mass to have the pieces forged into a horseshoe, which is now at the Museum of Practical Geology, London. (W. Flight, "Report of an Examination of the Meteorites of Cranbourne," etc.)
Denton County ..	1859	12.25 kilogrammes wrought into walking-stick handles and similar objects by a smith at MacKinney.
Descubridora ..	1870	Knife blades and even watch springs have been made from this iron. (Dr. Burkard, *Am. Jour. Sc.*, IV., 75.)
Elbogen	Known for centuries.	Neumann had a knife blade made. (Klaproth, *Journ. of Chem. and Phys.*, 1812, vol. 3.)
El Inca	1903	A piece was beaten into a thin plate. (G. Rose.)
E. Ranchito ..	1863	Part forged into a ploughshare. (Fletcher, *Mining Magazine*, vol. 9, p. 107.)
Estherville	May 10, 1879.	A ring (now in the Vienna collection) was wrought from a fragment; also a rod.
Guildford County ..	1822	Practically all used for horseshoes and nails by local blacksmiths (Shepard.)
Hammond Township	1884	A large portion used by local smiths; only 24 kilogrammes left. (Cohn, III. 406.)
Holland's Store ..	1887	Only 5 kilogrammes left, the rest converted into horseshoes, nails, etc. (G. F. Kunz, *Am. Jour. Sc.*, 1887, p. 471.)
Hopewell Mounds ..	Prehistoric	Celts, head and ear ornaments, as well as beads, were wrought from this iron by a neolithic people.
Ilimaë	1870	Worked by Indians into stirrups, spurs, spear-heads, and knives; bright like silver. (Fletcher, *Mining Magazine*, 1889, vol. 8.)
Imilac	1822	Worked into stirrups, spurs, spear-heads, and knives by a smith in San Pedro; bright like silver. (Fletcher, *Mining Magazine*, 1889, vol. 8.)
Iredell	1898	Partly forged into knife blades, etc. (W. M. Foote, *Am. Jour. Sc.*, 1899, p. 415.)
Jamestown	1854	Part has been rolled cold into a ribbon. (Huntingdon, *Proc. Am. Ac. of Arts and Sc.*, 1890 (2), p. 230.)
Lénarto	1814	Partsch and Brudern had a sword blade made from a portion, which is said to have the hardness of steel and to show the damascene markings.
Melville Bay (Ross-iron)	1818	Knives, lance-heads and other implements made from this by the Eskimos.
Medagolla	Jan. 23, 1870	Forged into sword, dagger, and knife, after mixing with manufactured iron. (G H. Saxton, *Proc. Asiat. Soc., Bengal*, 1870, p. 64.)
Pallas Iron ..	1749	Wrought into objects.
Pittsburgh	1850	Nearly the whole (132 kilogrammes) has been wrought into a rod. (Shepard.)
Prambanan	1797	At Solo, in Central Java, damascened blades of a high quality were forged from the Prambanan iron, but as this precious metal was entirely reserved for the weapons of the Sultan of Solo, the requirements of others were met by an artificial combination of thin plates of iron and nickel welded together in order to obtain the required pattern resembling the Widmanstätten figures in the finished weapons. Four beautifully finished daggers were made for the Sultan from the Prambanan iron, and these are now in the Ethnographical Collection at Vienna.
Sacramento	1876	A knife blade was forged from a fragment. (W. M. Foote, *Am Jour. Sc.*, 1897, p. 65.)
San Angelo	1897	A portion was used in a blacksmith's shop. (H. L. Preston, *Am. Jour. Sc.*, 1898, p. 269)
Schwetz	1850	A wrought specimen is at Göttingen.
Senegal River ..	1716	Wrought by the South African negroes into weapons, and even into shallow pots. (E. Howard, *Phil. Trans.*, 1802, pp. 206 and 211.)
Shingle Springs ..	1869	Rescued from the forge of a blacksmith. (B. Sillman.)
Smithland	1839	Partly used by local blacksmiths (Cohn, III. 101.)
Staunton	1858	Mallet had a fraction forged into the blade of a penknife. (*Am. Jour. Sc.* (III.) II. 10.)
Toluca	1776	Forged largely by the Mexican natives of the Toluca Valley into agricultural implements.
Tombigbee River ..	1878	A horseshoe nail was made from a fragment. (W. M. Foote, *Am. Jour. Sc.*, 1899, p. 153.)
Tonganoxie	1886	The original owner made a fish-hook from a fragment. (E. H. S. Bailey, *Am. Jour. Sc.*, 1891, p. 385.)
Tula	1846	Mostly wrought into axes, wagon-springs, and boat anchors. (Haidinger.)
Vaca Muerta ..	1861	Wrought by the Indians into stirrups, spurs, and horse trappings.

As a further proof that most meteoric iron may be used practically in the same way as manufactured iron, we will now review a number of interesting experiments.

Dr. L. Beck experimented on one complete individual of the Toluca fall weighing 180 grammes. The hardness when sawn asunder proved very variable. The analysis by Dr. Kraft was:—Iron, 86.181 per cent.; nickel and cobalt, 9.943 per cent., etc. (The many individii of the same fall differ very materially.) The first experiment was quite unsatisfactory. The iron proved somewhat ductile when cold, and had a tendency to separate along the crystalline planes. When heated the same behaviour was manifested under the hammer, and under welding heat it would not adhere, but broke up under the hammer; neither would it weld together with soft manufactured iron. This failure of the first of Beck's experiments is important, as other experiments such as with Salt River iron, Louisville, Kentucky, have been equally unsuccessful, and as they have not been repeated under altered conditions, the irons have been wrongly designated non-malleable. (The Salt River iron was smashed under the hammer of a local blacksmith in a rough attempt to forge it. The fragments have, however, none the less been found malleable.)

Dr. Horstmann, of Celle, was more successful, and produced an arrow-head from a portion of the selfsame meteorite, and in addition to this Dr. L. Beck was shown other productions of the forge

wrought from other specimens of Toluca iron. This tangible evidence in favour of the malleability of Toluca iron induced him to conduct a second experiment, this time quite a success, and he says, "I can only attribute my former failure to the supposition that the piece of metoric iron experimented with first had been penetrated by moisture along the crystalline surfaces, which must have been covered with thin films of rust which prevented adherence in the endeavour to weld."

We see thus with what caution the verdict non-malleable must be received, if a keen observer and metallurgist like Dr. Beck was very nearly deceived.

For his second test Dr. Beck used charcoal from beech wood. He found the iron harder and less bendable than the manufactured article, but it yielded well to the hammer in a moderate welding heat. The piece was wrought into a small rod, and this was welded to a similarly shaped rod of common iron. The weld was sound but easily recognisable. This was still more the case after the whole was polished and treated with acid, so that the two sorts of iron appeared very distinct. Beck states that meteoric iron has not the attributes of steel though harder than iron,* and that the usual hardening process by chilling it in water has little effect except on the surface—the interior remaining unaltered—so that the rod could be bent just as easily after chilling as before. This is confirmed by Wm. P. Blake, who reports that the iron from Babb's Mill is perfectly malleable, and the surface of a fracture is fine and granular like east-steel. Thin pieces may be bent back and forth repeatedly without breaking. A fragment heated to redness and quenched in cold water is not perceptibly hardened, and may be, as before, spread into thin sheets under the hammer. Its malleability is not impaired.

Experiments have also been conducted on Toluca iron by Messrs. Stein, father and son (long resident in Mexico in the vicinity where this iron fell), who have many specimens of this great fall—including an individual of 100 kilogrammes—which have been wrought by their orders and by their own smith into hammers, letter-weights, etc. The smith reports as follows:—"The forging operation was one of the usual procedure. Naturally charcoal was used in the forge, and as the pieces were somewhat flawed, welding heat was necessary. The objects must be forged in white heat, and occasional reheating is therefore necessary. The finishing touches were more difficult as the file would not bite uniformly, the material being harder in places, so that grinding had to be resorted to. Tests have also been made to anneal the meteoric iron for twenty-four hours in a charcoal furnace, but this did not soften the iron much."

Edwin E. Howell says that he found a piece of Toluca iron crumble under the hammer when heated to a white heat. This throws some light on the fact that sometimes the natives have been unable to use individuals of the Toluca fall, and have, therefore, thrown them away. L. Fletcher says that the Pallas iron, though ductile, so that it can be forged cold or at a moderate heat, is brittle at a high temperature.

Another interesting test of meteoric iron was made in the experimental station at Krupp's Steelworks with Bethany iron. A small rod was forged for this test, 4.25 millimetres wide by 2.05 millimetres thick, and the tensile strength was found to be 41.4 kilogrammes per square millimetre, and the elongation 5.6 per cent. of the original length. The fracture showed a slight flaw and the surface assumed a leaden hue. A bending test of 180 deg., i.e., the rod was doubled back upon itself, both cold and in red heat, showed no signs of fracture. The rod so bent was raised to welding heat and welded together, forged out and wrought to a chisel shape; the point was then broken off cold, and the fracture showed a sound weld.

A very careful investigation as to the physical properties of the Descubridora iron has been reported by Dr. Burkard. Wire wrought from this iron is found to possess an unusually high elasticity. The resistance of the iron to rupture by compression=38 kilogrammes, to rupture by tension=40 kilogrammes per square millimetre. The coefficient of linear expansion when heated between 0 deg. and 100 deg. C.=0.00002336783.

Dr. Beck says in substance that meteoric iron, although generally ductile, was not suitable for the edged tools of the ancients on account of its want of homogeneity, lack of elasticity, and its rarity. On this latter objection we shall have something to say later, but as to the two former objections, let us see what Sowerby says of the Cape iron:—"It is extremely pure and compact, it is not elastic when sawn into slices, but is easily rendered so by hammering. A shaving taken from the surface by a chisel is elastic without any further operation. It is so ductile and free from flaws that it may readily be rolled into sheets thinner than paper without cracking, and its hardness is such that it takes an excellent polish. These properties render it an excellent material for a sword-blade." The writer has in his possession a small knife (from the well-known collection of James R. Gregory) made of meteoric iron, the thin blade of which is as elastic and retains as keen a cutting edge as any steel blade. Even ignoring these facts concerning an ideal meteoric iron, it must appear obvious that Beck's objections might perhaps hold good in the present day, but in antiquity such iron was a vast improvement on all previously known materials for tools and weapons, which were only of stone or copper.

Charles Upham Shepard used malleability of meteoric iron as the attribute for classification, but the only four irons which he mentions under brittle or non-malleable are, however, in three cases either pseudo-meteorites or telluric, and the remaining one (Burlington) a genuine meteorite, is brittle but yet malleable. In 1854 Forchhamer divided meteoric iron into cast and wrought iron, by which he means respectively such rich in carbon and others poor in carbon. J. D. Dana goes further and says:—"Meteoric iron is perfectly malleable, and may be readily worked in a forge and put to the same uses as manufactured iron." Sir H. A. Miers says:—"It is indeed more than probable that the most of the iron used by primitive people who had not learned the art of treating ores, was derived from masses of meteoric iron. and it is to be noticed that in Siberia, Mexico, Chili. and Arabia, lumps of such material were not only used for weapons, but were much prized on account of their reputed heavenly origin."

Professor G. Hinrichs, of St. Louis, U.S.A., speaking of meteoric iron, says:—"It is this form of iron that has been first used by man. The Cyclopes forging the thunder-bolts of Jupiter is but the mythological expression of this fact."

(To be continued.)

* Sowerby in "Exotic Minerals" tells us that the Cape meteoric iron has the elastic attributes of steel after hammering.

Finishing Patterns.

By James Edgar.

When the various parts of a pattern, such as branches, brackets, ribs, etc., are screwed on the main body, or in the case of a core-box when all internal facings and ribs are fixed, and there is no more edge-tool work to be done, the work is ready for finishing. What may be termed "finishing" patternwork comprises sandpapering, filleting, filling holes, painting, and varnishing. It is not wise except in the case of parts that will be loosened in the sand, to finish the various parts separately, because it is not possible to foresee where fillets and rounds will be advisable, before the work is built. There is among craftsmen much difference of opinion as to the degree of finishing required with patterns. Some foremen consider that any time spent after the work is constructed is wasted, while others pay more attention to the finished appearance of the job than to the method of construction. The former type of foreman considers the economical working of his own department, without regard to the net cost of the castings, a tendency which is too prevalent in large works. In some pattern shops, where large and small work is made, the small class of work is well

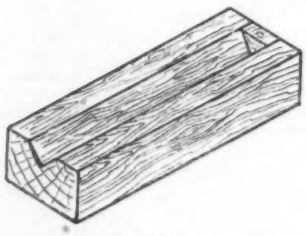


Fig. 1.

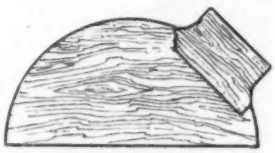


Fig. 2.

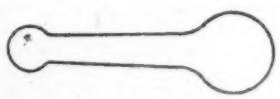


Fig. 3.

finished, while the larger work is left rough. This is a great mistake. It may be true that the same degree of accuracy is not necessary with a large casting of thick metal, as with small fine work, but this is not the sole, or indeed the chief consideration when finishing patterns. It is a question of ultimate cost. A rough pattern results in a costly casting. All standard patterns, or those from which a large number of castings will be required, cannot be too well finished. The initial cost will soon be saved in the foundry. Only rush jobs should be allowed to leave the pattern shop unpainted.

There is usually too much sandpaper used on patterns. Sandpaper does not always give good results. The practice of rubbing planed surfaces, for instance, should be discouraged. A sharp plane will make the most level surface; invariably scrubbing it afterwards with a rubber will leave hollows, and these hollows are a very serious defect, if they are on the side of a pattern, as they lock and do not deliver readily from the sand. For smoothing round corners, fillets or bends, of course, sandpaper is invaluable; but it should always be preceded by the spokeshave or plane. To rely upon the sandpaper rubbing down sharp corners or lumps is to invite inaccuracy. On work from the turning lathe it is seldom necessary to use sandpaper at all, yet it is more used here than at the bench. When it is pressed on work revolving in the lathe, especially segmental work, it forms a very uneven surface. If a templet is tried at various parts afterwards, the shape will be found to vary at each place, and to be correct nowhere. As segments show on the surface both side and end grain, the side grain wears first, and leaves the end grain raised. If sharp tools are properly used in a lathe which is running true, sandpaper is not needed. The hand should never be used as a pad or rubber for the sandpaper. If the ordinary flat cork is not convenient, a suitable one made of soft pine is easily made, whether for a concave or convex surface.

All screws and other holes should be filled with putty, shellac, or plaster-of-Paris. It is immaterial whether this is done before or after the work is sandpapered. If holes are not filled, the moulder has more finishing to do to his mould, and it is probable that he will take out screws by mistake, and so weaken the pattern. Only those screws should be seen which it will be necessary for the moulder to unscrew. As a filler beeswax is sometimes used, but it does not set sufficiently hard. If the pattern is subjected to heat the wax melts. Shellac is better. The best method when filling with shellac is to make a stick. A wire or screw is first heated then dipped into the shellac. Some adheres and this is dipped again and again until a stick sufficient for the purpose is got. Shellac sets very hard and can be scraped level. Plaster-of-Paris is troublesome to use, but it is a good filler. Putty is the simplest of all, and it has the great advantage that if the pattern at any future time is altered, it is easily picked out of the screwholes.

There are several methods of making fillets. They may be cut from the solid, or if straight they may be planed on a V-board like Fig. 1 and glued on afterwards. Leather fillets are very popular now, and although beeswax is sometimes used for this purpose, the same objection as for filling holds good here. Cutting solid fillets is good practice when dealing with loose pieces. In making standard patterns, it is often possible to let a loose branch or a boss into the body of a pattern, as shown in Fig. 2, and cut a fillet round it. This obviates the danger of a feather edge, which would be easily broken. In cases like this the leather fillet is of no use. Fillets cut from the solid are too expensive, however, for general practice. Leather fillets are easily fastened and adhere well. They should never be nailed on. Some patternmakers steep them in water before glueing, but the proper way is to wet the outside face first, then glue the inside face and rub them in position. The glue ought to be thin. The best rubber for leather fillets is one made of brass, and of a dumb-bell shape like

Fig. 3. The brass does not stick to the fillet if glue escapes, as the finger or a piece of shaped timber would do. The precaution of damping the face of the fillet is necessary if the pattern is not to be painted, otherwise in the damp sand the glue will soften, and the fillet curl off. The moulder is often left a free hand as regards fillets, but filleting the patterns ensures a much neater job. It is often very difficult to rub off corners in inaccessible places in the mould, and it takes considerable time. The great advantage, however, of fillets is, that the moulder get a clean lift. Sharp corners ought always to be avoided, as the most careful moulder cannot always avoid tearing his mould.

Every pattern and corebox should be painted. It is the only way to prevent timber from warping and swelling, and good results cannot be obtained from a pattern that changes its shape in the mould. Before it can be drawn, it will have to be rapped so much that in all probability the metal will be thicker than is necessary, and the moulder will have a good deal of making-up to do—and making-up is always unsatisfactory. There are several patent coloured enamels now on the market, but the writer's experience is that ordinary paint well sandpapered and afterwards coated with shellac varnish is hard to beat. Gloss is not wanted so much as a permanent smooth surface. It is a good practice to colour the prints differently from the pattern, and also to draw the metal on the joint. If machined surfaces are shown distinctly, the moulder will take the precaution to obtain a good face.

Repairing Open-Hearth Furnaces whilst in Work.

In 1914 a system of construction was introduced by the Clyde Furnace Company ("A"), Limited, of 38, Bath Street, Glasgow, the aim of which was to provide means whereby the existing blocks and air and gas ports of regenerative open-hearth furnaces could be maintained in an efficient working condition without the necessity of shutting down or losing a cast. A leading feature

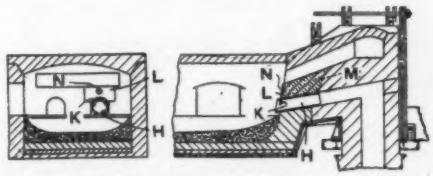


Fig. 1. Fig. 2.

Method of Repairing Open-Hearth Regenerative Furnace.

of the invention was that a so-called "centre" of iron or steel was used upon which a plastic refractory mixture was built up and moulded to the required shape. It has been found difficult, however, in practice to finish off solidly at the front the plastic material in certain cases and under certain conditions, and the Furnace Company, therefore, have recently applied for and been granted a new patent, the object of which is to provide in conjunction with the metal "centre" referred to means whereby the refractory material can be supported at the front whilst in its plastic state until it has properly set and hardened. This is effected with the help of a steel or iron retaining plate, which is let into a slot or cross-cut at the top of the "centre." Our Fig. 1 is an internal end view of the furnace showing the "centre" H with its retaining plate L in elevation, and Fig. 2 is a longitudinal section of the furnace showing the new plastic material M resting on the "centre." The plate L has a hole N for purposes of handling, and may be fixed at a suitable angle into the inclined slot K.

PREPARATION OF PURE MOLYBDENUM.—Mr. C. H. Humphries, of the Commercial Research Company, Long Island City, U.S.A., in a paper devoted chiefly to the preparation of pure grades of molybdenum, read before the American Chemical Society, stated that molybdenite, MoS_2, is the principal source of metallic molybdenum. In order to obtain the pure metal the trioxide or ammonium molybdate has generally been used, as the starting point, made from the sulphide, and this is reduced in an atmosphere of hydrogen in an electric furnace, producing a crystalline material which passes through several more stages of purification. The crystalline product is placed in a nickel or nickel-plated boat in a gas furnace, and heated to 900 to 1,000 deg. C. It is then crushed and screened, and reduced again for several hours at 1,200 deg. C. It is then examined for oxide by inspection. It would be desirable to reduce finally near 1,400 deg. C., but there is danger of the material becoming contaminated with iron if a nickel-plated iron boat is used. After the final reduction the metal is powdered, then pressed in a steel mould, and heated in an electric furnace for about half an hour at 1,200-1,300 deg. The metal sinters and becomes hard, but is not yet suitable for working. It is then placed in a furnace, the air displaced, and a current of about 100 amperes is passed through the metal. It shrinks and forms a true molybdenum rod. It is then swaged and made into smaller rods, wire, foil, etc. The swaging is done hot from the electric furnace at about 1,400 deg. The metal runs through dies of high speed steel down to 0.001 in. The smallest size for practical purposes is 0.005 to 0.01 in. If the pure metal is heated to 1,200 deg. several times and quenched the surface can be made glass hard.

In view of the exactitude with which engineering material is now required to conform to certain specifications it has become an absolute necessity for all classes of manufacturers to ascertain as fully as possible the physical and other properties of the materials they are using and producing; but not every firm feels itself justified in going to the expense of equipping a complete testing laboratory and further of efficiently staffing it with men of acknowledged practical experience backed by scientific training. In these circumstances special interest attaches to the announcement of the Crittall Manufacturing Company, Limited, Braintree, that, having gone to the trouble of establishing a complete testing department, they are prepared to assist engineering and other similar firms with the advice of their experts based upon the results of their investigations with modern apparatus. The company state that they are able to undertake complete chemical analysis of all metals and alloys, also various raw materials, including coal and fuel, refractories, etc. Heat treatment and pyrometer tests are also made, and microscopical examinations undertaken of all classes of metal. They have a most up to date photo-micrographic apparatus. On the mechanical side they perform tests to determine the physical properties of iron, steel and all other alloys, and by the aid of a 30-ton universal testing machine of most modern design can report upon tensile tests. Transverse, bending, compression and shearing tests are also conducted, as well as tests of hardness by the Brinell and Ludwik methods.

American Foundrymen's Association: Annual Meeting.

The twenty-second meeting of the American Foundrymen's Association was held at Boston (U.S.A.), on September 24 to September 28, inclusive. The programme of papers, etc., included the following :—

American Foundrymen's Association.

Joint opening session of the American Foundrymen's Association and the American Institute of Metals, under the chairmanship of J. P. Pero (President of the American Foundrymen's Association).

Address of welcome, by Hon. James M. Curley, mayor of the City of Boston, and response by R. A. Bull (Coraopolis, Pa.).

Annual addresses by J. P. Pero, Missouri Malleable Iron Company, East St. Louis, Ill., President of the American Foundrymen's Association, and Jesse L. Jones, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., President of the American Institute of Metals.

Report of the Board of Directors of the American Foundrymen's Association, Inc., and report of the secretary-treasurer.

"Fire Prevention in Large Industrial Establishments," by C. W. Johnson (East Pittsburgh, Pa.).

"The Foundry from the Viewpoint of the Sales Engineer," by H. R. Atwater (Cleveland).

"The Relationship of the Engineering Department to the Pattern Shop and Foundry," by F. J. McGrail (Warren, Pa.).

"How Character Analysis Solves the Man Problem," by W. J. Kibby (Cleveland).

Report of A. F. A. Committee Advisory to the U.S. Bureau of Standards, by Dr. R. Moldenke, chairman.

"Efficiency in the Foundry," by J. A. Fitzgerald (Reno, Pa.).

"Co-Operative Shop Training," by W. B. Hunter (Fitchburg, Mass.).

Report of A. F. A. Committee on Classification of Technical Literature, by Dr. R. Moldenke.

"Facilities for Technical Training at Massachusetts Institute of Technology," by J. Ritchie, Jun. (Boston).

"Improving the Relationship Between Employer and Employé," by J. F. Kent (Birmingham, Ala.).

Report of the A. F. A. Committee on Safety, Sanitation, and Fire Prevention, by V. T. Noonan, chairman.

Report of A. F. A. Committee on Foundry Costs, by B. D. Fuller, chairman.

Address on Cost Work of the American Foundrymen's Association, by C. E. Knoeppel (New York).

Report of A. F. A. Representatives on the Conference Board on Training of Apprentices, by F. M. Leavitt, chairman.

Report of the A. F. A. Committee on Industrial Education, by F. M. Leavitt, chairman.

"The Labour Situation as Relating to Co-operation between the Employer and Employé," by G. E. MacIlwain (Wellesley, Mass.).

"Micro-Metallography for the Foundry," by R. J. Anderson (Cleveland).

"The Theory of the Modern Waste-Heat Boiler and Possible Application of such Boilers to the Malleable Melting Furnace," by A. D. Pratt (New York).

"Application of Waste-Heat Boilers to the Malleable Melting Furnace," by C. D. Townsend (Danvill, Ill.).

"Application of Pulverised Coal to the Air Furnace," by W. R. Bean (Naugatuck, Conn.).

"The Application of Pulverised Coal to Malleable Melting Furnaces," by J. Harrington (Chicago).

"How Malleable Iron has Improved," by E. Touceda (Albany, N.Y.).

"Troubles Encountered in Machining Malleable Iron: Causes and Remedies," by A. T. Jeffery (Dayton, O.).

"Comparative Carbon Losses in Malleable Iron Annealing by Muffle and Pot Oven Methods," by J. B. Deisher (Rochester, N.Y.).

"The Effect of Iron Oxide in Moulding Sand," by W. R. Bean (Naugatuck, Conn.).

"Note on Fine Moulding Sands," by C. P. Karr (U.S. Bureau of Standards, Washington, D.C.).

Report of A. F. A. Committee on General Specifications for Gray Iron Castings, by W. P. Putnam, chairman.

"Briquetting Foundry Borings," by A. L. Stillman (New York).

"Cast Iron Shells in Permanent Moulds," by E. A. Custer (Philadelphia).

"The Seasoning of Gray Iron Castings," by L. M. Sherwin (Providence, R.I.).

"Factors in the Economical Production of Small Cores in Large Quantities," by R. E. Kennedy (Urbana, Ill.).

"Modern Centrifugal Cupola Blowers," by L. C. Loewenstein (Schenectady, N.Y.).

"The Effect of High Sulphur in Grey Iron Castings," by T. Mauland (Chicago).

"Moulding and Casting Large Slag Pots," by C. J. McMahon (Chicago).

"A Description of a Small Open-Hearth Furnace," by D. McLain (Milwaukee).

"Steel Castings for Ordnance Construction," by Major C. M. Wesson (Watertown, Mass.).

"A New System of Burning Crude Oil," by W. A. Janssen (Davenport, Ia.).

"The Use of Vanadium in Steel Castings," by J. Lloyd Uhler (Pittsburgh).

Report of A. F. A. Committee on Steel Foundry Standards, by W. A. Janssen, chairman.

"Notes on an Electric Furnace Design," by J. A. Crowley (Detroit).

"Recent Developments in the Application of the Electric Furnace to the Melting Problem," by D. Walker (Chicago).

"Comparison of Electric Furnace and Steel Converter for the Manufacture of Small Steel Castings," by C. R. Messinger (Milwaukee).

"The Electric Furnace from the Central Station Standpoint," by E. L. Crosby (Detroit).

"Solution of Foundry Transportation and Conveying Problems," by R. E. Newcomb (Holyoke, Mass.).

"Sand-Blasting in the Foundry," by H. L. Wadsworth (Cleveland).

"Experiments to Determine the Most Effective Means of Mixing and Blending Foundry Facing Sands," by R. Harrington (Boston).

"Oxy-Acetylene Welding and Cutting," by S. Plumley (Boston).

"Factors Contributing to the Economical Use of Grinding Wheels in the Foundry," by W. T. Montague (Worcester, Mass.).

"Refractory Materials Employed in the Metallurgical Industries," by H. C. Arnold (Urbana, Ill.).

American Institute of Metals.

"Raw Materials Used for Crucibles," by Prof. A. V. Bleininger (U.S. Bureau of Standards).

"Melting Yellow Brass in New Form of Induction Furnace," by G. H. Clamer (Philadelphia).

"Casting Bearings in Sand and Metal Moulds," by R. R. Clarke (Pittsburgh).

"Negative Experiments on Waste Core Sand," by Dr. H. W. Gillett (U.S. Bureau of Mines).

"The Crucible Situation," by M. McNaughton (Jersey City, N.J.).

"The Electric Furnace and Non-ferrous Metals," by Dwight D. Miller (New York).

"My Experience with Metal-Melting Furnaces," by W. H. Parry (Brooklyn, N.Y.).
"The Briquetting of Non-ferrous Light Metal Scrap," by A. L. Stillman (New York).
"The Present Status of Tin Fusible Plug Manufacture and Properties," by Dr. G. K. Burgess (U.S. Bureau of Standards).
"Stellite," by Elwood Haynes (Kokomo, Ind.).
"The Use of Die Castings in Munitions," by C. Pack (Brooklyn, N.Y.).
"Shrapnel Bullets," by H. J. Roast (Montreal).
"A Few Points on Alloy Patents," by Wm. J. Rich (Washington, D.C.).
"The Use of Bronzes in Railroad Turntables and Movable Bridges," by O. E. Selby (Cincinnati)
"Recent Industrial Uses of Aluminium," by F. G. Shull (Boston).
"The Consumption of Copper and its Varied Uses," by H. D. Hawks (New York).
"Comparative Tests on Test Bars and Actual Castings," by W. M. Corse (Niagara Falls, N.Y.).
"Analysis of Babbitts and Brasses," by E. W. Hagmaier (Buffalo).
"Standard Test Bars of 88-8-4," by C. P. Karr.
"The Expansion Coefficient of Alpha and Beta Brass" and "The Corrosion of Manganese Bronze under Stress," by Dr. P. D. Merica (Bureau of Standards).
"Corrosion of Brasses of the Muntz Metal Type," by H. S. Rawdon (Bureau of Standards).
"The School End of the Job in Training Foundrymen," by Dean C. B. Connelley (Pittsburgh).
"The Flux and Cleaner Question of Brass," by E. D. Frohman (Pittsburgh).
"Pyrometers—Their Construction and Application," by J. P. Goheen (Philadelphia).
"Electrically-Heated Core Ovens," by Dr. C. F. Hirshfeld (Detroit).
"Brass Rolling-Mill Alloys," by R. A. Wood (Cheshire, Conn.).
"The Electrolytic Production of Antimony," by Prof. D. J. Demorest (Columbus, O.).
"The Electrical Properties of some High Resistance Alloys," by Prof. M. A. Hunter and F. M. Sebast.
"The Amorphous Theory in Metals," by Z. Jeffries (Cleveland).
"The Volatility of Zinc and Cadmium," by J. Johnston and E. Schramm (St. Louis).
"Surface Tension and Deoxidising of Metals," by W. J. Knox (New York).
"Antimony—Its Metallurgy and Uses," by K. C. Li (New York).
"Development and Reabsorption of the Beta Constituent in Alloys which are Normally of the Alpha Type," by Prof. C. H. Mathewson (Yale University), and P. Davidson (New Haven, Conn.).
"The Swelling of Zinc-Base Die Castings," by H. M. Williams (Dayton, O.).

DANGER OF COMPRESSED OXYGEN. — According to the Chief Mining Engineer of the U.S. Bureau of Mines, there have been many explosions, in various parts of the States, of tanks containing oxygen made by the electrolytic process, due to the presence of hydrogen. Investigations made by the Bureau proved that in all cases where sufficient data have been obtained the oxygen has been used in conjunction with a torch for welding or cutting, and the flame has flashed back through the mixture. It is possible that ignition may occur by a jet of oxygen playing on carbonaceous material under certain special conditions, but in all cases the real danger is in the hydrogen getting into the oxygen, and it has been found that this is due to improper design in the manufacturing apparatus—that is, the cells and electrical connections; to insufficient safeguards connected with the electric apparatus, the polarity suddenly and unexpectedly shifting; to the manufacture of oxygen without frequent analyses; and to incompetent or ignorant attendants.

Open-Hearth Furnace Dimensions.

Mr. V. Grun-Grzhimailo, the well-known metallurgist, has published in a recent issue of the "Journal of the Russian Metallurgical Society" a table showing the increased dimensions he suggests for open-hearth furnaces of different capacities used for making steel by the ore process as compared with those used in the scrap process. Basing his calculations on data furnished by Mr. Pavlov in a previous issue of the same journal, he arrives at the dimensions shown in Table I. (converted into English equivalents) for furnaces used in the scrap process. The type of hearth adopted for his calculations is rectangular in shape, with a bottom width of 1.2 m. (say 4 ft.), and with slopes forming an angle of 26½ deg. with the horizontal. The initial depth of the bath is assumed to be 40 cm. (say 15¾ in.). While in the scrap process the bath only increases about 1½ times in volume: in the ore process, owing to the more vehement ebullition, the bath increases as much as from 2 to 2½ times in volume. Consequently, to save undue wear of the sides and roof of the furnace, provision has to be made for an increase of about 17 to 18 per cent. in the surface of the bath, as shown in Table II. The author shows cross sections for two 30-ton furnaces. Up to a level of ½ m. (say 1 ft. 8 in.) the two sections are alike, but in the case of the hearth for the ore process provision is made for an extra depth of 0.2 m. say 8 in.) for the bath, and the angle of the slopes in this portion is made 45 deg., giving a top width of 3.6 m. (say, 11 ft. 10 in.), as against 3.2 m. (10 ft. 6 in.) in the hearth for the scrap process. The increase in width of the surface of the bath works out at from 17 to 18½ per cent.

TABLE I.—*Scrap Process.*

Capacity of furnace.	Dimensions of bath.	Surface area of bath.	Height of roof from bath.	Cub. contents of combustion space.
Tons.	Ft.	Sq. ft.	Ft.	Cub. ft.
15	21.32 × 8.52	181.70	5.25	954
20	23.45 × 9.18	215.29	5.91	1,271
25	26.25 × 9.84	258.35	6.15	1,589
30	27.89 × 10.50	290.64	6.56	1,907
40	31.00 × 11.48	355.22	6.56	2,543
50	34.45 × 12.46	430.57	7.15	3,178
60	36.74 × 13.12	484.39	7.87	3,814

TABLE II.—*Ore Process.*

Capacity of furnace.	Dimensions of bath.	Surface area of bath.	Height of roof from bath.	Cub. contents of combustion space.
Tons.	Ft.	Sq. ft.	Ft.	Cub. ft.
15	22.37 × 9.57	215.29	4.43	954
20	24.61 × 10 31	254.04	5.00	1,271
25	27.47 × 11.07	304.63	5.21	1,589
30	29 20 × 11.81	344.46	5.53	1,907
40	32.41 × 12.89	417.66	6.09	2,543
50	35.96 × 13.98	502.69	6.32	3,178
60	38.39 × 14.76	566 20	6.73	3,814

THE ELECTRIC FURNACE IN JAPAN.—According to an article in "The Far Eastern Review," in the manufacture of special steels in Japan the use of electricity is now coming into vogue. The Wakamatsu Iron Works and the Fujitagumi Steel Works at Kirokawa, Inawashiro, are now equipped for this purpose. The latter employs 3,000 kilowatts of electricity and produces chiefly ferro-silicon, and at Osaka Harbour also tungsten and chrome alloys. Some other concerns are engaged either in trials or in the manufacture of the special products mentioned. At Yasuki and Yoneko ores prepared from sand iron are being dealt with in electric furnaces.

New England as a Foundry Centre.

In connection with the Annual Meeting of the American Foundrymen's Association and the American Institute of Metals, at Boston (Mass., U.S.A.), the following interesting particulars have been issued :—

New England, entering its 275th year in the casting of metals, has attained a position in the foundry industry of the United States which bids fair to remain unshaken as long as manufacturing retains its firm grip on the north Atlantic coast. Of the 6,000-odd foundries in the country at the present time, over 600, or about 10 per cent., are situated in the States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. Grey iron and brass castings were among the earliest products of the New England colonies, and in 1916 the number of iron and non-ferrous casting plants in the six States aggregated more than 10 per cent. of the total number in the United States. Malleable iron and steel castings were introduced in New England many years after the other branches of the foundry industry had become firmly established. Only 5 per cent. of the steel foundries, and 9 per cent. of the malleable cast-iron plants of the country are located in the New England States.

The first iron foundry in New England was built on the west bank of the Saugus river, near the present site of Lynn, Mass. According to early records, the village which grew up around the foundry was called Hammersmith, after a town in England from which several of the workmen had come. Joseph Jenks is reported to have cast "a small iron pot, capable of containing about one quart," which is thought to have been the first casting made in New England. The iron was smelted from bog ore obtained from the low-lying swamp land in what is now eastern Massachusetts.

Hollow-ware was cast as early as 1724 near Taunton, Mass., and in 1725 the foundry was casting hollow vessels varying in size from a pint kettle up to a "10-pail" cauldron. The foundry was rebuilt in 1816, and at the end of that year 30 men were employed at the plant. The product was carried to New York in sloops which brought back pig-iron and ore from New Jersey.

These foundries were the forerunners of many others which came into existence in the eighteenth century. In 1784 there were 76 iron works in New England. Although many of these were bloomeries and forge shops, it is thought that about 20 were engaged in making castings. In the north end of Boston, Paul Revere established a bell and cannon foundry which was in operation until 1801, when he erected a copper-rolling mill at Canton, Mass. Hugh Orr operated a foundry at Bridgewater, Mass., before the revolution. Cannon were cast solid and then bored in this shop, and machinery castings were made. In 1829 the first stove foundry in the United States was erected at Taunton, Mass., and in a few years the making of castings for stoves and heating appliances became an important industry.

The development of the foundry industry from the time of the American revolution was influenced to a considerable extent by the gradually changing economic position of New England in the United States. Massachusetts, Connecticut and Rhode Island, which for many years had provided the other States with practically all of the manufactured goods which they used, were obliged to relinquish their hold on several important industries. The blast furnaces of Salisbury gave way to those in the Pittsburgh district, and several other lines of manufacturing were established in the west where raw materials were more easily obtained. In the meantime, however, the Yankee ingenuity of the New Englanders had given them a firm hold on certain industries, many of which are peculiar to New England to this day. Clocks, small tools, hardware, paper, cotton and woollen cloth, paper, silverware and fine machine tools and brass goods became the principal products, and it is to the success achieved in producing these articles that the foundry industry in New England owes its prosperity and position of eminence to-day. In general, the majority of New England foundries are engaged in making castings for the machinery which produces the typical products enumerated, and in providing rough castings from which the products are made. The output of many foundries is required to supply the 900 boot and shoe manufacturing establishments of Massachusetts with the necessary machine equipment. This is also true of the hundreds of textile plants, the 300 carriage and wagon shops, the 800 machine tool builders, 100 manufacturers of electrical machines, etc. Other outlets for castings are the machine tools, motors, appliances, engines, marine motors, propellers, gun mounts and carriages, etc.

In 1916 327 casting plants produced grey iron in New England; 347 made brass castings, 229 melted aluminium, and only 11 cast malleable iron. The foundry industry in New England is in an exceedingly flourishing condition at present.

NEW U.S. NAVY SPECIFICATIONS FOR STEEL CASTINGS.—The U.S. Navy Department has issued new specifications for steel castings dated May 1, 1917, and superseding those issued on June 1, 1916. The chemical and physical properties now demanded are as follows :—

Grade.	Impurities. (not over).		Physical requirements.				
	P Per cent.	S Per cent.	Minimum tensile strength, lbs. per sq. in.	Minimum Yield point, lbs. per sq. in.	Minimum elongation per cent in 2 in.	Minimum reduction of area per cent.	Bending test† (not less than) Deg.
F* ..	0.05	0.05	85,000	53,000	22	35	120
A ..	0.05	0.05	80,000	45 per cent.	17	20	90
D ..	0.05	0.05	70,000	of tensile	22	30	120
B ..	0.06	0.05	60,000	strength	22	30	120
C ..	0.06	0.07	—	—	—	—	—

* Grade F castings may contain nickel or other alloying metals.
† Cold bend round an inner diameter of 1 in.

Grade A is intended for all important parts subject to crushing or surface wear only, such as turret roller paths, engine guides, etc. Grade B is intended for parts subject to tensile or vibratory stresses, such as stems, stern posts, rudder frames, struts, cylinders, gun-mount stands, carriages, slides, and other parts subject to the shock of recoil. Grade C is intended for gun mounts, such as brackets, levers, wheels, etc., not subject to shock of recoil, and for commercial fittings where structural strength and separation of watertight compartments are not involved. Grade D is intended for the same general purpose as Grade B, but where greater strength is required with equal ductility. Grade F is intended for castings for gun yokes, gun-mount stands, carriage slides, deck lugs, and other castings of large size.

British Foundrymen's Association.

Presidential Address before Lancashire Branch.

The opening meeting of the session was held on October 6 at the Municipal School of Technology, Manchester. On the request of the new President (Mr. Key) Mr. H. Sherburn presided.

Mr. Key, in the course of his presidential address, said :—

Status of the Foundryman.

By the term foundryman, I mean those on whom the success of the output of the foundry depends. The moulder, the patternmaker, and the metallurgist are all essential to obtain this success, and the best results should be obtained when this combination is co-operating mutually. Unfortunately, however, there are only a few foundries in this country where ths combination is available, and my observations are intended to apply more to the foundryman who is individually responsible for the successful working of the foundry.

Almost every day the foundryman is called upon to undertake some task more difficult than before; castings have to be made to withstand pressures up to 4 tons per sq. in. Jobs that were originally cast in sections are now required in one piece, sometimes making a very bulky casting, attended with great risks, although effecting a considerable saving in the finished article. Nevertheless it is the ingenuity of the foundryman which must accomplish the desired end.

Castings of complicated design, calling for a great amount of forethought, are desired. One is called upon to turn out work as cheaply as some other foundry (which is doubtless provided with special tackle for the job) with whatever tackle is at hand, often quite unsuitable for a competitive job, and to do all this with whatever material is sent in, irrespective of its quality. It is a common opinion that there is no branch of the engineering trade which requires such a combination of technical and practical knowledge, as is required to successfully manage a foundry.

Often has a foundry foreman to carry the burden of a non-practical foundry manager, the manager receiving all the credit when there is any about, while the foreman receives all the blame, which is more prevalent. There is just as good organising talent to be found amongst the practical, studious men as there is amongst the non-practical men. Therefore the man at the head should be both practical and have the necessary ability to get the work out, and be paid accordingly, which I do not not consider to be the case to-day.

The majority of the foundries in this country are worked upon the system of placing a responsible person in charge of that department, called the foundry foreman, but often without the necessary power or authority to run the concern as successfully as it might be. In the case of a shop running on repetition work, the task is not quite as difficult, in comparison with the foundry which has a variety of work ranging from ounces to tons, and which is seldom producing the same class of castings for two weeks together. In many cases the power of the foundry foreman is confined to controlling the men under him, and he is expected to obtain the best of results. He is often supplied with unsuitable material, with which he has to manage, sometimes at the expense of a considerable amount of bad work.

Under the best of regulated conditions, one will get some indifferent work in the foundry, especially in the case of the general engineering jobbing foundry. The success is primarily in the hands of the foundry foreman, and when one considers that each job requires separate treatment, the man in charge is naturally a very busy person, as moulders vary somewhat in mental efficiency and ability.

Let us briefly survey what is required of a foundry foreman. In the first place, he requires a governable temper, good organising ability and initiative. He should not be too conservative to consider a suggestion, even though it may be submitted by a boy. A diplomat can always gain his point more readily than a bully. He should study each man's temperament separately, and treat him accordingly. These are the main features a man should possess as rudimentary qualifications. Couple these with a thorough practical knowledge of every operation, from the cupola to the fettling shop, and the possibilities are he is the right man.

As a preliminary, he is handed a certain number of orders for castings, and in due course receives the patterns, templates, or loam boards. He has to carefully consider in detail the design and duty of each particular job, select what he considers is suitable tackle, and a man to make the job, and instruct him freely as to any details out of the ordinary, such as gating, feeding, easing, camber, setting of cores, and at the same time he must have the coremaker on the job, so that there can be no misunderstanding between the moulder and coremaker. Having gone so far, the result of a satisfactory mould is left to the ability of the moulder and coremaker. The weighting and the fastening down of jobs should, of course, all be examined by the foreman before proceeding to fill the mould, provided, of course, it is a job of any size. Generally speaking, the foreman has little time to attend to detail work on any job once he has given the job out, for there is always a fair amount of clerical work that requires attention, and every day brings its own problems. Then comes the question of suitable iron for casting the various classes of work, and often this is where the foundry foreman is severely handicapped, for he has often to put metal into a casting which his own knowledge suggests will just answer the purpose, but at the same time it may not be suitable for the best life of the job. It is not every foundry foreman who has a free hand in selecting his material; generally the firm has a buyer, sometimes going under one name and sometimes under another. His practical knowledge is not always what it should be, and 5s. per ton difference in price between two classes of pig-iron will often cause him to buy the cheapest. Coke is another item where price to the buyer is the governing feature. I remember a foundry where it was the practice to use a medium grade coke. With that coke they could not do better than a 6 to 1 net ratio. A change was advocated, and another brand of coke was ordered at 10s. above the previous price paid, with the result that a better quality of melted iron was obtained and gave a 9 to 1 net ratio. This was a case of where the foundry foreman was recognised as being the proper person to determine which was the cheapest and correct material to use. Take the case of cast-iron scrap.

Some person comes along with an alluring offer of a considerable quantity of good, clean scrap at marine-store price. Often the offer is closed with at once, with the result that the foundry foreman has another burden to carry until all the consignment has been disposed of. Scrap is a very useful commodity, but if 50 tons of scrap are credited to the foundry, and out of that amount perhaps only 30 tons of iron are obtained, whilst the rest of the weight has required a considerable consumption of coke to melt, and at the same time giving slag troubles, it is difficult to keep general expenses to the desired level. A man who understood the economical working of the cupola would refuse to buy such scrap.

There are numerous controlling factors in materials which are necessary for the production of good castings, which can only be judged by careful technical study and a good practical experience combined.

Again, the appliances which exist in some foundries are absolutely unfit for good practice. (I sometimes think that had some of the bombs which have been dropped in this country, dropped on some of the so-called cupolas, the war would have accomplished something useful.) Nevertheless, the foundry foreman is supposed to get good results, and should be complain, he will doubtless be told that good iron was obtained from that cupola 30 or 40 years ago. The fact is forgotten, however, that iron was iron in those days, and was altogether stronger and more consistent in quality than that which is commonly produced now.

Another great mistake which is made in many cases is in connection with the financial side of the foundry, which, as before stated, is controlled by the ability of the foreman. Firms are generally very reticent at allowing the foreman to see the dissection costs of the working of the foundry. I am convinced that for the successful working of the foundry, the counting house should supply a monthly or even a weekly statement of accounts in detail—not necessarily customers' accounts. A foreman can easily persuade himself that his department is doing well. So it may be, but in a busy establishment it may be one section that is keeping the total on the right side; whereas if a full dissected account were prepared, it might be found that another department was not doing as well as it should be. For instance, moulding costs might be below the average, taking into consideration the weight and class of castings turned out, while at the same time labouring or other charges may have increased—a matter which would require attention, and could be dealt with if details were available. A little more confidence by the firm in the responsible head of the foundry would certainly be conducive to better results, yet it is very little more than a crime with some firms to ask for detailed information of this description.

The patternmaker should exchange ideas with the foundry foreman, so as to determine the cheapest method of making a job inclusive of both charges. The foundryman who has the interest of his employers at heart would not have an expensive pattern made if he could produce the castings at net cost, including pattern making, by using strickles or templates.

Where a job is left entirely to the pattern shop, one sometimes finds that this department will save themselves 20 per cent. on making a pattern, which may mean 100 per cent. increase in moulding costs and ultimately prove a net loss to the firm.

I have a case in mind of one firm which for any job which was circular made loam boards, and I have known as many as 20 loose pieces to be set out and bedded in, the job weighing only only 1¾ cwt. and six to be made off. To the practical foundryman this condition of things is deplorable, whilst at the same time he is expected to produce those castings as cheaply as those made elsewhere under more favourable conditions. Of course, this is an exceptional case, where the pattern shop was simply working in its own interests, but it goes to prove how necessary it is for the foundry foreman to be consulted before commencing to make a job. I do not assert that these remarks apply to all foundries, for there are many where the responsible foundryman has the necessary power to buy where or how he thinks necessary.

Summing the matter up, therefore, it is necessary for the man who is to assume the responsibility of conducting the foundry to possess knowledge or experience, far more than in any other branch of the trade; and he should be given the full confidence of the firm, and have a free hand in selecting materials and appliances that may be necesary, in order to ensure the commercial success of the undertaking. At the same time he should be paid proportionately. It does not take long to determine a man's capabilities.

Is the foundry foreman sufficiently paid in proportion to the skill and knowledge required? When one looks around and can see journeyman moulders on piecework earning more than the foreman, one is inclined to ask whether the position with its attendant trials and troubles is worth studying for. If the foundryman's lot were improved it would certainly be a greater allurement for a better class of boy to the foundry, and I venture to suggest that it would be one stride to help to solve the difficult task of the Committee who have in hand the question of the training of aprentices.

The apprenticeship question is one which at the present time presents great difficulties, inasmuch as the industrial world is in a very unsettled state. It is possible there may be great changes after the war in industrial conditions, and although we should be prepared to come forward with suggestions to help to solve the question of the training of apprentices, we shall be best employed, perhaps, by reserving them until the world has resumed something like definite conditions.

The need, however, for considering this matter is very great, for unless we can provide some inducement for boys to make themselves proficient above the ordinary, our reputation in the world as craftsmen is sure to deteriorate. It is to a great extent in the power of the foreman to help the success of any scheme that may be brought forward, for it is quite as easy to make a boy become interested in his work, as it is to make him dissatisfied, providing, of course, that the boy has come with the intention of taking advantage of opportunities to learn.

The CHAIRMAN, in moving a vote of thanks to the speaker, said he cordially sympathised with many of the observations contained in the address, and he hoped they would bear fruit.

Mr. Key then submitted a short Paper on a "Quantity Job in a Jobbing Foundry," minutely illustrated by his own drawings.

Trade Talk.

THE Norwegian Government has prohibited the export of chrome ore, except under licence.

CONSIDERABLE damage was caused on October 13 by a fire at the engineering works of Messrs. Fletcher & Company, Tilbury.

MR. A. MCLAREN, agent in Glasgow for Messrs. Jones & Campbell, Torwood Foundry, Larbert, has removed to 8, Springfield Court, Glasgow.

THE exportation of cast scrap iron from Canada is prohibited to all destinations abroad except the United Kingdom, British Possessions and Protectorates.

MESSRS. JOHN CRAN & COMPANY have secured a site at Leith for an additional yard in which to build vessels of larger size than they are at present constructing.

THE STANDARD METALS, LIMITED, 59-61, New Oxford Street, London, W.C., have forwarded a trade catalogue showing the firm's present stock of weldless steel tubes.

MESSRS. A. P. SMITH and F. W. A. Smith, trading at Pelham Street, Wolverhampton, under the style of the Clyno Engineering Company, have dissolved partnership.

ROPNER & SONS, LIMITED, of Stockton, are at present in negotiation with the Stockton Corporation for the acquisition of 3,296 sq. yds. of land for the extension of their shipyard.

MESSRS. W. BROWN, L. Brown, W. H. Brown, and A. Brown, engineers, trading under the style of W. Brown & Sons, 20, Temple Street, Wolverhampton, have dissolved partnership.

E. T. PEARSON & COMPANY, LIMITED, 49, Watling Street, London, E.C.4, have taken over the rights for France and the French Colonies of the Wild-Barfield process for hardening steel gauges, tools, etc.

A SCHEME of extensions at the shipyard of Robert Thompson & Sons, Limited, Southwick, which is of some importance in the development of the Wear as a shipbuilding centre, is nearing completion.

DR. ADDISON informed MR. KING last month that the question of a decimal system of weights, measures, and coinage was being considered by the Committee on Commercial Policy after the War.

IT is understood that the iron ore deposits in the Edge Hill district will be worked by T. & I. Bradley, Limited, Capponfield Furnaces, Bilston, in conjunction with T. & I. Bradley & Sons, Limited, of Darlaston.

A FIRE broke out on October 2 on a ship at the yard of Swan, Hunter & Wigham Richardson, Limited, Wallsend. The vessel, which was a large one, was almost ready for launching. The damage was considerable.

THE Iron and General Metal Trade Section of the Incorporated Chamber of Commerce of Liverpool have passed a resolution protesting against Government interference with the legitimate merchant in the pursuit of his business.

HYDRAULIC GEARS, LIMITED, Beaver Lane, Hammersmith, London, W.6, have acquired from Compayne, Limited, the British rights for the manufacture and sale of Hele-Shaw hydraulic pumps, motors and transmission gears.

FURTHER land adjoining the works at Darnall, of Kayser, Ellison, & Company, Limited, has been acquired during the year, and very considerable progress has been made with the erection of buildings, plant, and machinery.

THERE is in course of erection at the blast furnaces of the Dalmellington Iron Company, Limited, a new turbo-blowing plant to replace the old beam engines, which have been in constant use since the commencement of the works, 70 years ago.

THE Controller of the Foreign Trade Department has issued a new list of additions to the statutory list of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade.

THE partnership heretofore subsisting between Messrs. F. F. Akroyd and J. Marsland, carrying on business as tool and gauge manufacturers, at the Precision Tool Works, Dyson Street, King Cross, Halifax, under the style of Akroyd & Marsland, has been dissolved.

EXTENSIVE developments are to be carried out in the near future at the shipbuilding and ship-repairing yards of Messrs. Scott & Sons, Bowling. The company have acquired ground to the east of Bowling Harbour, and propose constructing a basin and graving dock.

A GRANT has been made by the Industrial Research Committee of the Board of Education to Professor G. H. Bryan, of the University College of North Wales, which will enable him to devote the whole of next session to special research work in aeroplane construction of national importance.

THE Merchants' Sub-section of the Metal Trade Section of the London Chamber of Commerce have approved of the suggested Federation of British Merchants. The Premier has refused to receive a deputation of the members on the subject of the Government control of trade.

HEYWOOD BROTHERS (CARDIFF), LIMITED, have opened an office at Billiter Buildings, Billiter Street, London, E.C.3., where they will deal with all inquiries for manganese ore, manganiferous ore, iron ore, zinc blende and calamine, and pyrites. Inquiries for ferro-manganese, spiegel, pig-iron, etc., should be addressed to the Cardiff office.

RECENT stoker orders received by the Underfeed Stoker Company, Limited, includes 23 for electricity and gas works, 8 for the Lambton & Hetton Collieries, 4 for the Priestman Collieries, 8 for William Beardmore & Company, Limited, 2 for Sir W. G. Armstrong, Whitworth & Company, Limited, 1 for the Carlton Ironworks, and 2 for Richborough.

UNDER the auspices of the Ministry of Munitions, an exhibition of official photographs and samples of women's work was opened last month at the City Art Gallery, Birmingham. This exhibition illustrates the various types of work upon which women are employed in engineering and other industries on munitions of war. It will remain open until November 10.

THE contractors have made a start with laying out the new shipyard at Pallion, Sunderland, for the Egis Shipbuilding Company, in which Sir John Ellerman and Messrs. Gray are interested. The site, which is between 18 to 20 acres in extent, and comprises what was formerly Messrs. Oswald's shipyard, will provide for four or five berths, capable of holding ships 500 ft. long.

THE CALEDON SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, who have recently made considerable extensions to their works, have now leased 21 acres of land at Dundee for laying out an entirely new yard to be specially adapted to the building of vessels up to 15,000 tons d.w. The work in connection with this establishment will be taken in hand as soon as war conditions permit.

ON the occasion of the recent Glasgow meeting of the Refractory Materials Section of the Ceramic Society, the council appointed two sub-committees to prepare reports respectively on the standardisation of methods of testing and refractories for spelter furnaces. It is anticipated that the former will be ready for the spring meeting in Sheffield, and the latter for the subsequent autumn meeting at Cardiff.

THE SUNDERLAND SHIPBUILDING COMPANY, LIMITED, South Docks, Sunderland, have acquired from the Wear Commission a piece of reclaimed land to the east of the company's present berths, on which it is intended to make an extension of the shipyard by the addition of two new berths. The new site will permit the company to construct larger vessels than can be laid down on the present berths.

VICKERS, LIMITED, are making preparations for establishing a yard at La Plata for the construction and repair of merchant vessels. The concession provides for the formation of a joint stock company, the capital to be half in ordinary and half in preference shares. The former will be subscribed by the concessionaires

and the latter by the Argentine Government, either in cash or in bonds of the External Debt.

THE construction of shipbuilding parts is being undertaken by certain Birmingham firms. It has been found possible to adapt existing manufacturing plants to the production of parts according to a system of standardisation, and to turn out complete craft in this way, the parts being forwarded under distinguishing numbers to the coast, and there assembled. The capacity of the vessels ranges over five hundred tons.

THE ENGINEERING EMPLOYERS' FEDERATION OF GREAT BRITAIN are about to appoint as salaried officials two professional engineers to act as technical assistants at the head office. The intention is to assist employers on various points which are now rising, and which are referred to the Federation, but which require to be dealt with, not only from a technical point of view, but with an eye to preserving a consistency of policy.

WITH reference to the purchase of the works of the Frodingham Iron and Steel Company, Limited, Scunthorpe, Lincs., by Steel, Peech & Tozer, Limited, of the Phœnix Special Steel Works, Sheffield, and Samuel Fox & Company, Limited, Sheffield, it is announced that all the directors, except Mr. Mannaberg, who has acted as managing director, are to retire, and their places will be taken by directors appointed by the purchasers.

THE WESTMINSTER ELECTRICAL TESTING LABORATORY, York Mansion, York-street, Westminster, S.W.1, inform us that in order to facilitate the exploitation of the Wild-Barfield process of steel hardening, they have disposed of their rights governing this process to the Automatic & Electric Furnaces, Limited, of 6, Old Queen Street, Westminster, who are undertaking the installation of plants. A complete plant is still in operation in the Westminster laboratory, and demonstrations of its working will still be carried out.

ON October 12 the Secretary of State for the Home Department made an order under Section 7 of the Police, Factories, etc. (Miscellaneous Provisions) Act, 1916, in regard to ambulance and first aid arrangements at blast furnaces, copper mills, iron mills, foundries, and metal works. The order will come into force on December 1 next. Another order, dated October 9, deals with the supply of drinking water at certain factories and workshops. This order likewise comes into force on December 1.

THE creditors of the Worthington Pump Company, Limited, met in London last month for the purposes provided for in Section 188 of the Companies (Consolidation) Act, 1908. The liquidation is a voluntary one, for the purpose of amalgamation with James Simpson & Company, Limited, with whom the Worthington Pump Company, Limited, have been closely associated for many years. The business of the two companies will be carried on as hitherto at Queen's House, Kingsway, W.C.2, under the title of Worthington-Simpson, Limited.

AT a meeting of the North Lincolnshire Iron Masters' Association and of the local authorities at Scunthorpe, last month, Mr. Lee presided, and stated that in a very few years house accommodation would have to be provided for 30,000 or 40,000 additional people. They were anxious that the developments should be on good lines, and the ironmasters were anxious to work with the local authorities, so that the working men could be comfortably housed. It was decided that a town-planning scheme should be prepared at the expense of the ironmasters.

WE understand that the business of Messrs. E. H. Shorland & Brother, Failsworth, Manchester, has been disposed of by private treaty. In future all correspondence relating to the ventilating department (including the supply of Shorland's exhaust ventilators and fresh air inlets, etc.) should be addressed to Messrs. Henry Hargreaves & Sons, ventilating engineers, Bury, Lancashire. All correspondence relating to the patent "Manchester" stoves and grates and the heating department generally should be addressed to George Wright, Limited, of Burton Weir Works, Botherham, London and Manchester.

THE RIGHT HON. GEORGE ROBERTS, M.P., P.C., lit up, on October 20, the last remaining idle furnace at the works of the Stanton Ironworks Company, Limited, near Nottingham, which has been placed in commission for the purpose of making basic pig-iron out of local iron ore. The manufacture of basic pig-iron from local ore is a new industry in the Midlands, and not until the shortage of raw materials for steel-making purposes had made itself felt were the Midlands called upon to direct their blast furnaces to the manufacture of basic iron. The Stanton Company now have in commission nine furnaces and supply their own iron ore, coal, etc.

IN their 51st annual report the directors of Palmers Shipbuilding and Iron Company, Limited, state that the scheme of modernising the iron and steel works has made good progress, notwithstanding the difficulties and delays caused by the war. Some of the plant is now at work, and it is expected that a further portion will be in operation this month. Greater progress would have been made had not the Government commandeered for their new factories part of the plant ordered by the company for this scheme. The company has also made large extensions and alterations in the steel works and blast furnaces at the request of the Ministry of Munitions for war purposes.

THE DEPTFORD STEEL & IRONWORKS, LIMITED, have recently introduced a system of electro-deposition of zinc, which they have styled "Borrodising," for the purpose of preventing the corrosion of the steel fittings of aeroplanes and seaplanes. From some descriptive matter issued by the company we note that the method adopted is cold electro-galvanising, carried out in such a way that the zinc unites with the underlying metal, with the result that only by extraordinary wear can the surface of the steel be exposed. In addition, the metal is not subjected to the usual pickling bath prior to galvanising, and the company consequently claim that the strength of the metal after treatment is not impaired.

A MEETING was held in the theatre of the Institution of Civil Engineers, on October 25, for the purpose of considering the establishment of a central organisation for improvement in and better co-ordination of engineering training and the appointment of a representative committee of engineering and educational interests to initiate action. Sir Maurice Fitzmaurice, president of the Institution of Civil Engineers, presided. Those interested can obtain particulars from Mr. A. P. M. Fleming, British Westinghouse Company, Trafford Park, Manchester, or Mr. A. E. Berriman, chief engineer, Daimler Company, Coventry, who are acting as honorary organisers for the committee responsible for arranging this meeting.

THE MINISTER OF MUNITIONS has made the following appointments within the Ministry:—Major J. W. Hills, M.P., to act temporarily as a member of the Munitions Council in charge of the labour group, during the absence of Sir Stephenson Kent; Vice-Admiral Sir A. G. H. W. Moore to be Controller of the Mechanical Warfare Department; Major-General H. F. Thuillier to be Controller of the Chemical Warfare Department; Brigadier-General A. C. Currie to be Controller of Munitions Design; Mr. E. V. Haigh to be Controller of the Trench Warfare Supply Department; Mr. H. C. Bunderdown to be Director of the Agricultural Machinery Department; Major H. Newton to be Assistant Director of the Trench Warfare Department.

ACCORDING to a Proclamation dated October 18, the following headings have been deleted from the list of prohibited exports:—(*a*) Aluminium, alloys of aluminium and manufactures of aluminium; (*c*) arsenical ore; (*b*) fencing staples; (*b*) lead ore; (*b*) belting, hydraulic leather, pump leather, and leather manufactures suitable for textile machinery; (*a*) machinery, agricultural, and component parts thereof, including hand tools which can be used for agricultural purposes; (*c*) nails, wire; (*c*) wood-screws made of iron and steel. The following headings have been added:—(*a*) Aluminium, alloys of aluminium,

and manufactures of aluminium, or of its alloys; (*b*) arsenical ore; (*a*) lead ore; (*b*) belting, leather manufactures suitable for textile machinery, and leathers cut or shaped for hydraulic or pump purposes; (*a*) machinery, agricultural or farming, and component parts thereof, including hand tools for agricultural or farm purposes; (*a*) wood-screws made of iron or steel.

THE President of the Board of Education received on October 18 a deputation from the North-East Coast Institution of Engineers and Shipbuilders, who submitted recommendations on the education of apprentices. These recommendations were made by a committee of members of the Institution and of education authorities, specially appointed by the council. The deputation, which was introduced by the Duke of Northumberland, comprised Mr. H. B. Rowell (President of the Institution), Major-General Sir Percy Girouard (Chairman North-East Coast Engineering Trades Employers' Association), Colonel Sir Johnstone Wallace, Mr. W. H Dugdale, Mr. M. C. James, Mr. G. Jones, Mr. J. Marr, Principal V. A. Mundella, Mr. E. L. Orde, Mr. T. Putnam, Mr. G. Renwick, Mr. Percival Sharp, Professor R. L. Weighton, Mr. Tom Westgarth, Colonel R. Saxton White, and Mr. B. W. Fraser Smith. Mr. Fisher gave a very sympathetic hearing to the representations, and his reply was distinctly encouraging. A summary of the proceedings will, it is understood, be issued shortly.

THE work of women engaged in munition factories was officially recognised at Sheffield on October 7 by Mr. B. H. Morgan, technical adviser to the Labour Supply Department of the Ministry of Munitions. In the course of an interesting speech, he said that since the institution of the Ministry in 1915 the output of 18-pounder guns had increased over 30 times, 4.5 field howitzers over 50 times, medium guns and howitzers over 70 times, and heavy howitzers over 480 times. There had been criticisms of the Ministry, and he could not let the occasion pass without recounting the story he had heard of a Sheffield firm which wrote to the Ministry for a 6-in. lathe. In reply they were told that it was regretted a 6-in. lathe could not be supplied, but that the firm were welcome to two 2-in. lathes if they would do! He had recently made a comparison, in regard to certain work, of women's figures with those of men in a United States factory. He found that not only were their machining times as good, but in many cases they were better than in some of the best organised American shops.

THE London iron, steel, and metal merchants have decided to form an association to protect their interests, in view of the recent attitude of the Government in regard to merchant business. We understand that the association will be known as the National Association of Iron, Steel and Metal Merchants. Last month a largely-attended meeting of metal merchants, representing London, Newcastle-on-Tyne, Hull, Manchester, Liverpool, Edinburgh, and the Midlands, was held at Birmingham to consider the question of organising for the protection of their interests. Complaint was made that the merchant's place in the trade had been ignored in the control established by the Ministry of Munitions, and that merchants had been denounced in official quarters as parasites. Mr. J. G. Buchanan, of Messrs. Wm. Jacks & Company, of London, declared that German experience, as well as our own, proved the indispensability of the merchant. He urged they should concentrate on Parliamentary influence. A resolution was passed favouring the formation of a Federation of British Merchants, in which scheme London has given a lead.

THE first meeting of the twenty-fifth session of the West of Scotland Iron and Steel Institute took the form of a joint meeting with the Society of Chemical Industry held in the Societies' Room, Royal Technical College, George Street, Glasgow, on October 13 when a paper was read by Professor Berry, of the Agricultural College, Glasgow, on "The Recovery of Potash from Blast Furnace Gases." Professor Berry is investigating this subject on behalf of the Ministry of Munitions. Other meetings of the Institute will be held on November 16, December 21, January 18, February 15, March 15, and April 26, when the following papers will be read:—"Industrial Research," by Mr. C. H. Desch; "Our Imperial Strength, Based on the Metal Industries and an Efficient Banking System," by Mr. O. C. Beale; "Iron Works Efficiency, Some Engineering Features," by Mr. F. Anslow; "Boiler Plate Failure," by Dr. Wolffe; "Puddling Process Committee Report," by Mr. C. H. Desch; "Some Useful Testing Machines," by Messrs. J. S. G. Primrose and H. Primrose; "Welding of Iron and Steel," by Mr. W. H. Cathcart; "Malleable Cast Iron," by Prof. T. Turner.

THE General Purposes Committee on Government Control of Trade appointed by the Birmingham Chamber of Commerce has issued a supplementary report, in which it is stated that during the vacation a special meeting of export merchants and metal merchants was held to consider the serious position caused by the Government methods in controlling trade, and a series of recommendations approved by the London Chamber of Commerce were adopted subject to slight amendment. An emergency meeting of the committee was held, and as a result a letter was addressed to the Prime Minister, the Chancellor of the Exchequer, the First Lord of the Admiralty, the Secretary of State for War, the President of the Board of Trade, and the Minister of Munitions, stating that their view was that the Government should not act as a trading intermediary until the resources of existing commercial machinery are exhausted or are found to be insufficient; that to this end merchants should be encouraged to continue to both carry and import stocks of commodities essential to this country; that so far as any control of imports and exports is concerned the quantities allowed should be based as far as possible upon a fair allocation of quantities amongst merchants dealing in particular articles after consultation with representative trade organisations; and that the various control departments, assisted by representative men nominated by their respective trades, should be co-ordinated so far as to secure a uniform system on questions of principle and to obviate present delays in dealing with licences and permits.

MR. CHURCHILL delivered the introductory address at a conference of Boy Welfare Supervisors from works in different parts of the country, held under the auspices of the Ministry of Munitions last month. He said it was felt some time ago that, after nearly eighteen months of pioneer work in the field of boy welfare in the munitions department, it would be a good thing if a conference were held to bring together as many as possible of those who were actively engaged in this branch of our responsibilities, to enable them to compare experiences, and to evolve general principles based on experiences, which would be of immediate practical value in the months that lay before us. The Ministry of Munitions was the largest employer of boy labour, and, indeed, of every kind of labour, that there had ever been in the world. He was told that more than 250,000 boys were now working under the authority of that department, and they played a vital part in the production of the munitions of war. They had an immense responsibility in that respect, and the obligation was placed upon them to be a good employer and to be abreast of what the best employer in private enterprise and industry did. He took that occasion of recognising with admiration the work which had been done by many private employers, working under the Ministry or apart from it, in grappling with the evils of unregulated and exploited labour which marked the opening phases of the war. They must make sure that what had been found practicable, reasonable, useful, and helpful in different parts of the country should be swiftly extended wherever the responsibilities of the Ministry were involved. Wherever any considerable body of young people were engaged in industrial work there should be one man whose whole time, thought, and hope were wrapped up in their care and guidance. Subsequently the Rev. R. R. Hyde (Chief Welfare Officer for Boys) gave an address on the development of the welfare movement.

Personal.

Mr. G. Readman has been elected chairman of the Arizona Copper Company, Limited.

The late Mr. J. Russell, shipbuilder, of Ardrossan and Port Glasgow, left personal property of the value of £220,494.

Mr. W. H. Martyn, hitherto on the staff of Buck & Hickman, Limited, has received an appointment at the Ministry of Munitions.

The Right Hon. C. Addison, M.P., Minister of Reconstruction, has appointed Mr. W. A. Colegate to be his private secretary.

The late Mr. J. Benson, of Messrs. Harrop, Benson & Company, ironfounders and engineers, Pontardulais, left estate of the gross value of £17,114.

Mr. N. E. Peck, of Barclay, Curle & Company, Limited, has taken up a position in the Department of the Deputy-Controller of Auxiliary Shipping.

Mr. W. Barton-Worthing, who has retired from the presidency of the Institution of Civil Engineers, has been succeeded by Mr. H. E. Jones, a vice-president.

Mr. T. Hampson, who is the managing director of the Vulcan Motor and Engineering Company, Limited, has been asked to accept the mayoralty of Southport.

The gross value of the estate of the late Mr. F. J. Gresham (of Gresham & Craven, Limited), engineers, Knutsford, is £100,502, including £99,834 net personalty.

Lt.-Col. R. A. Hudson, D.S.O., West Yorkshire Regiment, who is reported wounded for the second time, is a director of Robert Hudson, Limited, Gildersome Foundry.

Mr. Andrew Jollie, assistant commercial manager, has been appointed commercial manager of the Steel Company of Scotland, Limited, in place of the late Mr. James M'Skimming.

The gross value of the estate of the late Mr. F. A. Hopkinson, chairman of directors of J. Hopkinson & Company, Limited, Britannia Works, Huddersfield, is £56,101, including £51,916 net personalty.

The Minister of Munitions has appointed Captain J. A. Webster to act temporarily as his private secretary in succession to Mr. H. H. Piggott, who has been appointed an Assistant Secretary of the Ministry.

Mr. A. L. Kewney, of Whitley Bay, who for some years has been in the service of Swan, Hunter & Wigham Richardson, Limited, Wallsend, has been appointed manager to Messrs. Amos & Smith, marine engineers, Hull.

Sir Maurice Fitzmaurice has been appointed by the Lord President to fill the vacancy on the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, caused by the retirement by rotation of Mr. W. Duddell.

Mr. John Nettlefold, chairman of Thomas Smith's Stamping Works, Limited, has resigned owing to ill-health. Mr. H. C. Aston, of Erdington, Mr. A. S. Hill, J.P., of Coventry, and Mr. J. H. Aston, J.P., of Wylde Green, Birmingham, have been elected directors of the company.

The Secretary of the Ministry of Munitions announces that, with the consent of the Minister of Munitions, Sir Alexander Roger, the Director-General of the Trench Warfare Supply Department, has relinquished his position in order to take up work in the Ministry of Reconstruction.

Mr. Walter McFarlane, principal of the County Metallurgical and Engineering Institute, Wednesbury, Staffordshire, has been elected an honorary member of the West of Scotland Iron and Steel Institute. Mr. McFarlane was an original member of the Institute, serving on the Council, and during his membership contributed several papers of great interest.

The Right Hon. the Earl of Crawford, who for a long period has been a director and, since the death of his father some years ago, the chairman of the Wigan Coal & Iron Company, Limited, has resigned his directorship of the company, in consequence of his holding the post of Lord Privy Seal in the Government, and Mr. Arthur Moore Lamb, J.P., of Wigan and Southport, one of the directors of the company, has been elected chairman.

Mr. R. McGregor, a native of Liverpool, has been appointed vice-president and general manager of the Federal Shipbuilding Company, a subsidiary company of the United States Steel Corporation. Mr. McGregor served his apprenticeship with Messrs. David Crawford & Company, of Liverpool, and was awarded the first Derby Scholarship in 1894, which enabled him to attend the Liverpool University. On leaving the University he joined the Leyland Line, and subsequently became superintendent engineer of the Eastern and Metropolitan Steamship Lines, U.S.A. In 1911 Mr. McGregor commenced private practice in New York as naval architect, consulting engineer, and ship surveyor.

Applications for Patents.

Aitken, T. W. Crucible furnaces for melting metals. 13,306. September 17.

Allcut, E. A., and Avery, W. and T. Impact-testing machines. 13,635. September 22.

August, J. R. C., and Hooson, H. V. Regenerative furnaces. 13,817. September 26.

Brayshaw, E. R., and S. N. Furnaces. 14,963. October 16.

British Thomson-Houston Company. (*General Electric Company*). Electric furnaces. 13,544. September 20.

Blast Furnaces & Equipment, Limited, and Ritson, P. Blast furnaces. 14,023. September 28.

Britannia Foundry Company and Smith, A. P. Foundry moulding-machines. 13,912. September 27.

Couper, A., and Mason, H. E. Manufacture of refractory bricks, blocks, tuyeres, etc., for furnaces. 13,906. September 27.

Crowe, H., and Dewhurst, J. H. Stripping ingots from moulds. 14,636. October 10.

Dixon, J. L. Electrically-heated steel furnaces. 14,932 October 15. (United States, October 14, '16.)

Dixon, J. L. Electric steel furnaces. 14,933. October 15. (United States, October 14, '16.)

Etchells, H., Watson & Company, and Greaves, H. A. Electric furnaces. 13,286. September 17.

Fletcher, Russell & Company, and Fletcher, T. W. Gas burners for furnaces. 12,583. September 18.

Foster, W. J. Blast furnaces. 15,008. October 17.

Granberg, J. G. Condensers for redistilling spelter. 13,405. September 18. (United States, December 8, '16.)

Howden & Company, J., and Hume, J. H. Furnaces. 13,382. September 18.

Howden & Company, J., and Hume, J. H. Furnace fronts. 14,463. October 5.

Jones, F. J. C. Annealing, normalising, and heat-treatment of metals, etc. 14,949. October 16.

Keith, G., and J. Crucible furnaces. 15,254. October 20.

Ketley, G. P. Method of recalcining mine ash, or dust or fine residue from calcination of ironstone or iron ore employed in metal production. 14,706. October 11.

Kynoch, Limited, and Kievits, J. E. P. Method of construction of electric furnaces of the heated-coil type. 14,838. October 13.

Ionides, A. C. Gaseous-fuel furnaces. 14,296. October 3.

Lorentowicz, L. Process of casting metal. 13,831. September 26.

MacGregor, P., and Balfour, A. Steel. 15,224. October 19.

Mate, W. C. A. Treatment of moulds for making metal castings. 14,456. October 6.

Portham, R. S. Locomotives 13,398. September 18.

Poulson, A. Treatment of moulds for making metal castings. 14,456. October 6.

Poulson, A., and Mate, W. C. A. Treatment of moulds for making metal castings. 14,566. October 9.

Price, C. P. Crucible furnaces for melting brass, etc., for casting. 12,452. September 9.

Price, C. P. Crucible furnaces. 14,497, October 8.

Singleton, J. H. Gas burners for furnaces. 13,583. September 21.

Stanowsky, A. Casting metal. 13,747. September 25. (Holland, September 27, 1916.)

Stansfield, A. M. Apparatus for re-metalling shaft-bearing brasses, etc. 13,430. September 19.

Stock, G. J. Process for synthetic production of low phosphorus and sulphur pig-iron from steel or iron scrap. 14,063. September 29.

Talbot, B. Ingot moulds for manufacture of steel. 13,966. September 27.

Talbot, B. Apparatus for compressing ingots. 14,088. September 29.

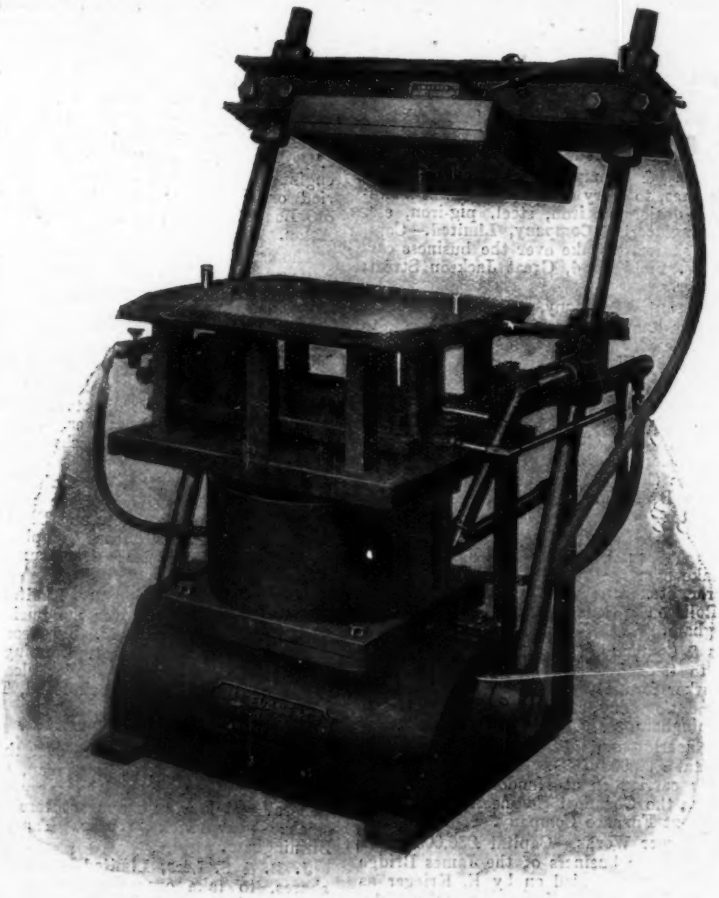
Tallis, C. E., and Tallis, E. Foundry moulding-boxes. 14,028. September 28.

Topham, W. Regenerative gas furnaces. 13,652. September 22.

MOULDING MACHINES

OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.



JAMES EVANS & CO., BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

New Companies.

Oldridge Engineering Company, Limited.—Capital £5,000, in £1 shares.

Stoic Steel & Tool Company, Limited.—Capital £2,000 in £1 shares.

Hydraulic Gears, Limited.—Capital £40,000 in £1 shares. Registered office: Beavor Lane, Hammersmith, London, W.

T. L. Harding & Sons, Limited.—Capital £20,000 in £1 shares (8,000 preference), to carry on the business of engineers.

Limit Gauges and Tools, Limited.—Capital £5,000 in £1 shares. The first directors are D. J. Niven and C. F. Lawton.

Furness Shipbuilding Company, Limited.—Capital £650,000 in £1 shares. The first directors are Lord Furness and W. Furness.

West Bromwich Metal Castings Company, Limited.—Capital £2,000 in £1 shares. Registered office:—Edward Street, West Bromwich.

Abrasives, Limited.—Capital £10,000, in £1 shares, to adopt an agreement between J. S. Mitchell, B. R Rowland & Company, Limited, and W. M. Rowland.

Bernard Nicklin & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in iron, steel, pig-iron, etc.

T. W. Field Engineering Company, Limited.—Capital £1,000 in £1 shares, to take over the business carried on by T. W. Field at 4, Great Jackson Street, Hulme, Manchester.

Corra Engineering Company, Limited.—Capital £3,100 (3,000 £1 ordinary and 1,000 2s. founders'), to take over the business carried on at 95-7, Lower Richmond Road, Putney, S.W.

Rootes, Limited.—Capital £10,000 in £1 shares, to carry on the business of engine construction and repairing experts, etc. Registered office:—Len Engineering Works, Mill Street, Maidstone.

Grosvenor Engineering Works, Limited. — Capital £2,000 in £1 shares (1,900 7 per cent. cum. pref.). The first directors are R. P. Murray and A. E. Morgan. Secretary, C. Sutton. Registered office: Poole Hill, Bournemouth.

Abel Rollason & Sons, Limited.—Capital £80,000 in £1 shares, to take over the business of a steel founder and manufacturer, etc., formerly carried on by J. Rollason as Abel Rollason & Sons, at Bromford Mill, Erdington, Birmingham.

Ansell, Jones & Company, Limited.—Capital £25,000 in £1 shares, to take over the business of a metal founder and worker formerly carried on by W. Ansell as Ansell, Jones & Company, at Naval Works, Kensington Street, Birmingham.

Chemical Engineering and Wilton's Patent Furnace Company.—Capital £20,000 (£1). To take over the business formerly carried on at Hendon by T. Wilton and G. Wilton as the Chemical Engineering Company and Wilton's Patent Furnace Company.

James Bridge Copper Works.—Capital £30,000 in £1 shares, to take over the business of the James Bridge Copper Works, formerly carried on by E. Krieger as Kenneth Page & Company at Walsall, metallurgists. etc., 42, Billiter Buildings, London, E.C.3.

Automatic & Electric Furnaces, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in furnaces, plant and materials for the hardening or other treatment of steel, etc. Registered offices: 6, Old Queen Street, S.W.

Hague & McKenzie.—Capital £10,000 in £1 shares, to take over the business carried on by Hague & McKenzie at 36, Barr Street, Birmingham, and to carry on the business of die sinkers, etc. Registered office: Sloane Buildings, Sloane Street, Birmingham.

Rapid Electric Arc Welding & Engineering (Ireland), Company, Limited.—Capital £5,000 in £1 shares (1,000 pref.), to adopt an agreement with J. L. Gordon. The first directors are J. L. Gordon & T. M'Kinty. Registered office: 45, Rosemary Street, Belfast.

Job Wheway & Son, Limited.—Capital £75,000 in £1 shares (20,000 preference), to take over the business of an ironfounder, etc., carried on at Green Lane, Walsall, as Job Wheway & Son. Registered office: the Birchills Hame and Chain Works, Walsall.

Gravesend Smelting and Refining Company, Limited.—Capital £2,000 in 1,900 ordinary shares of £1 and 2,000 deferred shares of 1s. each, to carry on the business of smelters and refiners. Registered office: 2, Gresham Buildings, Basinghall Street, E.C.

G. A. Close, Youle & Company, Limited.—Capital £5,000 in £1 shares, to carry on business as manufacturers and merchants of machine knives, etc. The first directors are G. A. Close and S. Berrisford. Registered office: 126, Charles Street, Sheffield.

C. J. Fox & Sons, Limited.—Capital £3,000 in £1 shares (1,500 preference and 1,500 ordinary), to take over the business of a manufacturing engineer, carried on at 65, King's Cross Road, London, as C. J. Fox & Sons. Registered office:— 65, King's Cross Road, W.C.1.

Kersons Manufacturing Company, Limited.—Capital £2,000 in £1 shares, to take over the business of engineers, machinists, and manufacturers in metal carried on as the Kersons Manufacturing Company, at 315 Long Acre, Birmingham, and Wainwright Street, Aston.

Thomas C. Keay, Limited.—Capital £20,000 in 10,000 preference and 10,000 ordinary shares of £1 each, to acquire and carry on the business of mill furnishers, etc., at 15, Baltic Street, and of engineers, etc., 7, Ogilvie Street, Dundee. Registered office: 15, Baltic Street, Dundee.

John Player & Sons, Limited.—Capital £75,000 in £1 shares, to carry on the business of ironfounders, iron masters, etc. The first directors are J. Player, W. H. Player, and W. J. P. Player. J. Player may retain office while holding £20,000 shares. Registered office: Clydach-on-Tawe.

Yser Works, Limited.—Capital £2,000 in £1 shares, to take over the business of mechanical engineers carried on by J. P. E. Ectors and E. M. E. J. H. Berckmans at Devereux House, Campbell Road, Twickenham. Registered office:—Devereux House, Campbell Road, Twickenham.

John Ferguson & Company, Limited.—Capital £1,500 in £1 shares to take over the business of an ironfounder carried on by H. Ferguson at the Victoria Foundry, Quadrant Street, Canning Town, and the business of a blacksmith, boiler cleaner and repairer, etc., carried on at 17, Dock Road, Tidal Basin, West Ham.

Harrold Manufacturing Company, Limited.—Capital £1,000 in £1 shares, to take over the business carried on in England by S. C. Perrymen, trading as Charles Harrold & Company, and to carry on the business of general metal ware manufacturers, etc. Registered office: — Warwick Works, Tame Road, Witton, Birmingham.

J. B. & S. Lees, Limited.—Capital £50,000 in £1 shares, to take over the business of an ironmaster, etc., carried on by J. Lees at the Albion Iron and Steel Works, Oldbury Road; at Nelson Iron Works, Greets Green Road; and at Swan Meadow Timber Yard, Swan Lane; all in West Bromwich, as J. B. & S. Lees, together with the land adjoining the Nelson Iron Works.

A. D. Keeling, Limited. — Capital £50,000 in £1 shares, to take over the business of a metal manufacturer and merchant carried on at Warstone Metal Works, Hall Street, and at Caroline Street Metal Works, Birmingham, and 15, Howard Street, Sheffield, as D. D. Keeling. Permanent governing director, A. D. Keeling. Registered office: Warstone Metal Works. Hall Street, Birmingham.

The Mastery

of the Air.

FANS

SEND US YOUR ENQUIRIES FOR

are always successful in the struggle for the Mastery of the Air

Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.

Davidson & Co., Limited, *Sirocco Works,* **BELFAST.**

T. & I. BRADLEY & SONS, LTD.,

DARLASTON, South Staffs.

SPECIAL COLD BLAST PIG IRONS.

Brands:

R.A.M. FOR CYLINDERS.

IXL. C.B.R. FOR CHILLED CASTINGS, &c.

D.M.R. CHARCOAL FOR MALLEABLE CASTINGS, &c.

✣ SELECTION ✣ ANALYSIS ✣ FRACTURE AND CHILL ✣ GUARANTEED ✣

ALL MINE.	WARM BLAST.	COLD BLAST.
◆ A M ◆	I X L.	I X L.-CB.

☛ IF YOU HAVE DIFFICULTIES WITH YOUR SPECIAL CASTINGS CONSULT US.
We can put you right.

Deaths.

The death is reported of M. Paul Planche, chairman of the Forges et Ateliers de la Loire.

Engineer-Lieutenant F. P. Jones, Royal Navy, is reported missing, believed killed. He was 39 years of age, and was an engineer at the Cyfarthfa Works before the war.

The death is announced of Mr. T. A. Carpenter, of Brook Side, Ilkley, and managing director of Buckton & Company, Limited, ironfounders, Leeds, at the age of 62 years.

Capt. L. C. Kirk, who was killed in action on October 9, was the younger son of the late Mr. F. H. Kirk, for many years director and secretary of Samuel Osborn & Company, Limited, Sheffield.

The death is announced of Mr. J. Barnes, chairman of the engineering and ship-repairing firm of Charles Howson & Company, Limited, Regent Road and Clarence Dock, Liverpool, in his 72nd year.

Sec.-Lieut. E. B. Butler, of the Royal Field Artillery, who has been killed on active service, was the son of Mr. H. B. Butler, chairman of Charles Joyner & Company, Limited, and director of Butlers, Limited, Small Heath.

Capt. J. A. G. Shanks, Argyll and Sutherland Highlanders, who has been killed in action, was previous to the war associated with his father in the firm of Shanks & Company, Limited, engineers, of Barrhead. He was 27 years of age.

Mr. B. Arkwright, head of the engine works department in Glasgow of Sir W. G. Armstrong, Whitworth & Company, Limited, died on October 2 at the age of 55 years. Educated at Harrow, the deceased went to Elswick as an apprentice. He became assistant manager of the engine works in 1888, and in 1902 was appointed manager of the department. He was elected a local director of the company in 1912.

Captain T. S. Spittle, Monmouthshire Regiment, who recently died of wounds, was the elder son of Mr. Thomas Spittle. The deceased gentleman was born in 1884, and graduated in engineering at Cambridge in 1906, becoming an associate member of the Institution of Civil Engineers a few years later. On the outbreak of war he was a director and engineer at the works of Thomas Spittle, Limited, Newport, Mon., which firm was founded by his great-grandfather.

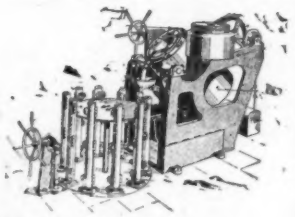
Mr. A. S. Johnstone, of Birmingham, died last month at his residence, Hillside, Rednal, in his 83rd year. An experimental and analytical chemist in mineralogy and metallurgy, Mr. Johnstone's work in the laboratory was of the greatest importance. He was the first in this country to render nickel and cobalt malleable, and he effected many improvements in the malleability of so-called German silver. Mr. Johnstone's services to the firm of Evans & Askin, now Henry Wiggin & Company, Limited, were recognised in 1875 when the late Sir Henry Wiggin made him a partner in the firm, and in 1892, when the business was converted into a private company, he became a director, a position which he retained until his death.

The death occurred last month at his residence, "Mayfield," Harborne Road, Edgbaston, of Mr. J. I. Parkes. The deceased gentleman, who was seventy-five years of age, was a son of the late Mr. I. Parkes, a South Staffordshire ironmaster, and the elder brother of Sir Edward Parkes, M.P. At an early age he entered his father's business, and on reaching his majority he became manager of the works at West Bromwich. Subsequently he took entire charge of the iron business at Smethwick, now known as John I. Parkes, Limited, and was the chairman of directors until his death. He also established the Birmingham Corrugated Iron Company, Limited, of which he became chairman, and he was also on the board of other industrial concerns.

A Revelation to Steel Founders!

Monometer Steel Melting Furnaces
(Hall's Patents)

¶ Tilting and Pit Types.
¶ Installed by leading works in Sheffield.
¶ Oil-fired.
¶ Better Steel than any other system.
¶ Unskilled labour.
¶ Quicker melting.
¶ More economical and efficient than electric furnace.



MONOMETER MFG. CO., LTD., Engineers and Ironfounders,
Edited by I. H. HALL, Managing Director.
ASTON, BIRMINGHAM.

H. J. EVANS & CO. Telegrams: "Gunmetal." Telephone: Bank 3842.
25, Lord St., LIVERPOOL.

METALLURGISTS' MANUFACTURERS, and MINE OWNERS.

Speciality: FERRO-SILICON, ALL GRADES. FUEL OIL FOR DIESEL ENGINES.

The following is a list of some of our lines, prices below competitors'. It will pay you to send us your enquiries :—

FERRO-ALLOYS, MINERALS, METALS & CHEMICALS, RADIUM-BROMIDE, FERRO-CHROME, FERRO-SILICON, FERRO-VANADIUM, FERRO TUNGSTEN, FERRO-MANGANESE, FERRO-MOLYBDENUM, FERRO-TITANIUM,

ALUMINIUM, CADMIUM, CARBONATE OF POTASH, SILICA, REFINED SULPHUR, FRENCH CHALK, ASBESTOS POWDER. **PLUMBAGO, GRAPHITE,** MANGANESE, LEAD ORE, FELSPAR,

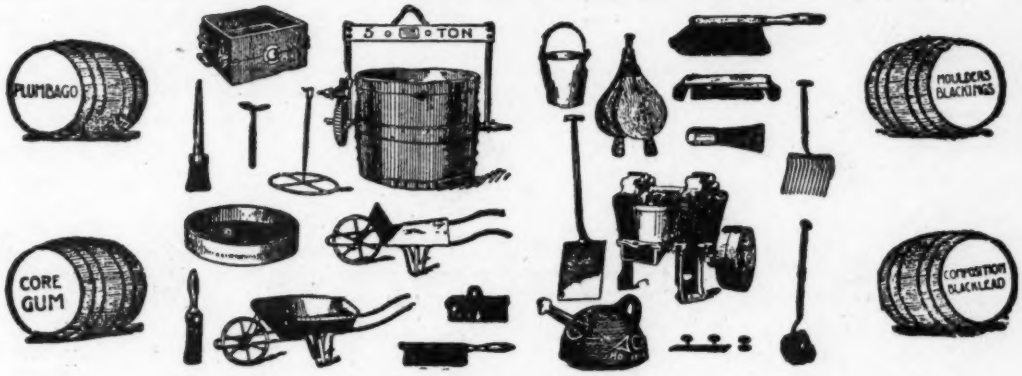
CALCINED MAGNESITE AND MAGNESITE BRICKS, FLUORSPAR, BOG ORE, BAUXITE, CHROME ORE, IRON ORE, SPENTOXIDE AND RETORT CARBON, OXIDES OF IRON, &c.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



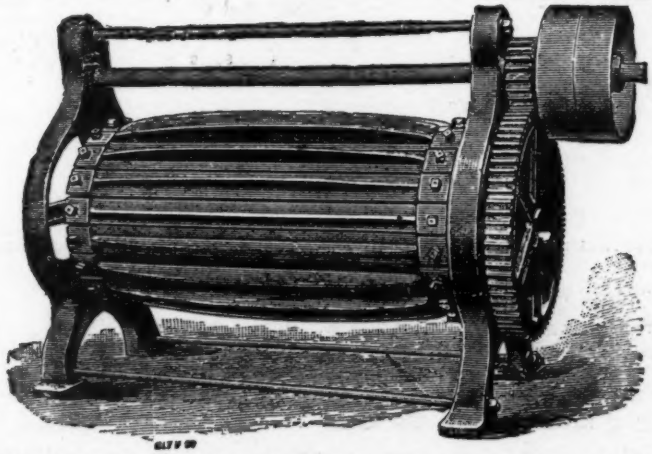
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos. 1, 2 and 3	6	7	6
Special under 0.03 P. & S.	6	15	6
„ „ 0.02 „	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S.	6	7	6
Special under 0.03 P & S.	6	15	6
„ „ 0.02 „	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	6	15	6
„ „ 0.02 „	7	0	0
HEMATITE—MALLEABLE— Refined—			
Refined Cupola Cast	8	0	0
Refined Cupola Cast to guaranteed analysis	8	5	0
Cast direct from Blast Furnaces—			
Small Pig-Iron, all grades	7	10	0
Medium Pig-Iron White to Grey mottled	7	5	0
Medium Pig-Iron, all other qualities	6	17	6
Large Pig-Iron, all grades	6	17	6
Lincolnshire, basic or foundry	4	12	6
Cleveland, No. 1	4	11	6
„ other grades	4	7	6
„ basic	4	17	6
Northamptonshire, forge	4	7	6
„ fdy numbers	89/0		94/0
„ basic	4	17	6
Derbyshire, forge	4	10	0
„ foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge	4	10	0
„ „ „ foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
„ „ foundry	4	17	6
„ „ basic	4	17	6
South Staffordshire—			
Part mine forge	4	15	0
„ foundry	4	17	6
Common Staffordshire	4	10	0
All mine forge	5	15	0
„ foundry	6	0	0
Warm air forge	7	5	0
„ foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Basic	4	17	6
Scotch foundry and forge—			
Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings .. .. 5d.

Bar Ends .. .. 6d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton	—		
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	—		
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	—		
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	—		
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	—		
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	—		
Ferro-titanium: 23/25%, per lb. carbonless	—		
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	—		
Ferro-phosphorus: 20/25%. Per ton	—		
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	—		
*Ferro-manganese 80%	25	0	0
„ export £36 0 0—39	0	0	

* F.o.b. Liverpool.

Non-Ferrous Metals.

	£	s.	d.	£	s.	d.
Copper.						
Standard, Cash	110	0	0	110	10	0
Three months	110	0	0	110	10	0
Electrolytic	125	0	0	121	0	0
Tough	123	0	0	119	0	0
Best selected	123	0	0	119	0	0
Tin.						
Standard, Cash	258	0	0	258	5	0
„ Three months	258	0	0	258	5	0
English Ingots				258	10	0
Bars			—		—	
Refined			—		—	
Spelter.						
American	54	0	0	50	0	0
Specials			—		—	
Hard			—	45	0	0
British	56	10	0	57	0	0
Lead.						
Soft Foreign	30	10	0	29	10	0
English			—		Nom.	
Antimony.						
Regulus			—	85	0	0
Aluminium.						
Virgin Metal 98/99% per ton			—		—	

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots	—

CASTINGS.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. £50 above price of best selected copper.

15 per cent. Phosphor Copper .. £70 above price B.S.

Phosphor Tin (5 per cent.) .. £30 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FARBLEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**			
98/99% purity, per lb.	—		—
***Nickel.**			
In cubes, 98/99% purity Per ton			—

	per lb.
Nickel Silver.	
Ingots for raising	—
Ingots for Spoons and Forks	—
„ rolled to spoon size	—
***Tungsten Metal Powder.**	
96/98% purity per lb.	—
***Molybdenum Metal.**	
96/98% purity per lb.	—
***Cobalt Metal.**	
97% purity per lb.	—
Quicksilver.	
75 lb. bottle	—

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

	s.	d.	s.	d.
Cleveland.				
Steel scrap, heavy melting	105	0	—	
Iron scrap cast (cupola metal)	90	0	95	0
London (f.o.b.).				
Heavy steel			105	0
Light „			55	0
Heavy cast			95	0
Control Prices.				
Heavy Steel Melting Scrap	105	0	125	0
Steel Turnings and Borings			70	0
Steel Turnings and Borings mixed with Wrought Iron, &c.			50	0
Steel Scrap, all other Classes			105	0
Wrought Iron Scrap	105	0	125	0

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap	—		
Hy. Selected Scrap Brass	—		
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap	—		
Re-melted Ingot Lead	—		

Stocks.

Metals.	Tons.
Copper, Europe and afloat	—
Tin London, Holland, U.S.A. and afloat	—

Coke.

	s.	d.	s.	d.
Middlesbrough.				
Gas Coke	32	0	—	
Foundry	42	6	—	
Glasgow.				
Foundry Coke	—		42	0
Furnace Coke	30	0	—	
Gas Coke	—			
London.				
Welsh or Durham Foundry, d/d London Stations in truck	45	6	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6	—	

CONTROL PRICES OF COKE.

	s	d.
Durham and Northumberland blast furnace	28	0
„ foundry	30	6
South Yorkshire, West Yorkshire, Lancashire, Staffordshire and Midland Counties blast furnace	25	8
South Wales blast furnace	30	0
„ foundry	43	0

All per ton net. f.o.t. ovens.

SITUATIONS VACANT AND WANTED.

FOUNDRY and WORKS MANAGER, at liberty, desires appointment; wide experience light castings trade. Must be Government work. Good organiser; first-class references.—Address, Box 908, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOUNDRY FOREMAN.—Wanted foreman for small but growing foundry in S.W. London. Good knowledge iron repetition work essential. Experience copper-alloy and aluminium useful. No person engaged on Government work or residing more than ten miles away need apply. Write experience, salary required.—Apply Box 912, Offices of the FOUNDRY TRADES JOURNAL, 165, Strand, London, W.C.2.

FOUNDRY MANAGER of large experience in modern methods of rapid production of iron and brass castings, together with a thorough knowledge of pattern-making in all its branches, seeks a new position.—Particulars, etc., Box 904, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

POSITION as FOUNDRY WORKS MANAGER wanted, by thorough practical man, 20 years' experience in complete charge iron, brass and aluminium; expert moulding machines; general engine castings in green and drysand and loam.—First-class references and full particulars sent on application to Box 914, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOUNDRY FOREMAN desires change. Age 37; progressive. Expert in plate pattern work and moulding machines—hand, hydraulic or pneumatic. Can handle men with tact and get best results Drysand and Greensand. Well up in piece work, and can mix to analysis. Specialist in wheels and pulleys.—Reply Box 902, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOR SALE AND WANTED.

SMALL Foundry Business FOR SALE through death of owner.—Address Box 906, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

WANTED, SAND BLASTING PLANT, complete or parts.—BISSELL, Engineers, Warwick.

BRITISH PATENT No. 108,426, of 1916, relates to a drop flask Moulding Machine, whereby the system of moulding is rapid, accurate and inexpensive. Sale or licence.—TURNER, 28, Plumper's Road, Sheffield.

FOR SALE, Ground Ganister for Furnaces, Steel Works, etc.; also Lump Silica Rock, Fire Bricks, Silica Sand and Cement, of the finest heat-resisting qualities. Guaranteed supplies during winter months.—Apply, THE NORTH BRITISH REFRACTORY CO., Head Office, Vicar Lane, Sheffield.

FOUNDRY LADLES, ungeared, from 28 lbs. capacity to 3 cwt. geared up to 6 tons capacity. Very prompt delivery for Government work. Also makers of cupolas, etc.—STEEL WORKERS, LTD., Charles Henry Street, Birmingham. 'Phone, Mid. 2182. Tgrams., "Structural, Birmingham.

FOR SALE AND WANTED.

WANTED to purchase copy of FOUNDRY TRADE JOURNAL for August and September, 1917.—Reply stating price to Box 910, Offices of the FOUNDRY TRADES JOURNAL, 165, Strand, London, W.C.2.

FOUNDRY MANAGERS, PLEASE NOTE. — Odd sides to register, made in plaster, are heavy or cost pounds; but by using rough wooden box parts and Turner's Patent Sockets, they will cost shillings.—TURNER, 28, Plumpers Road, Sheffield.

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL AND
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, SALFORD.

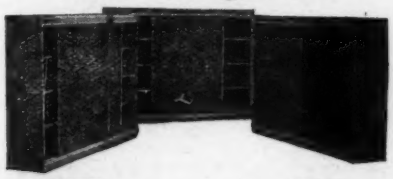
F. L. HUNT & CO..

FOUNDRY
FURNISHERS
AND
FOUNDRY REQUISITES
Of every description.

56, 58, 60, CHAPEL STREET, SALFORD, MANCHESTER.

SANKEY

Fireproof
Steel Storage Bins



CLOTHES LOCKERS, **TOOL CHESTS.**

Write for Details,

Joseph Sankey & Sons, Ltd.,
Hadley Castle Works,
Wellington, Shropshire.

PLUMBAGO. GLUTRIN.

Parting Powder.

WILLIAM OLSEN, LTD.,
Cogan Street, HULL.

FOUNDRY MATERIALS AND REQUISITES.

WIRE BRUSH MANUFACTURERS.
STRAW ROPES.

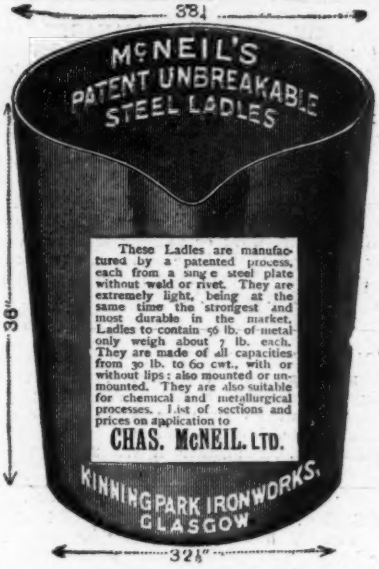
Wax Core Vent.

CORE OIL. CORE GUM.

FIRE BRICKS & CLAY
CUPOLA BRICKS.
Best Quality.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,
(STOURBRIDGE) Ltd.,
STOURBRIDGE.

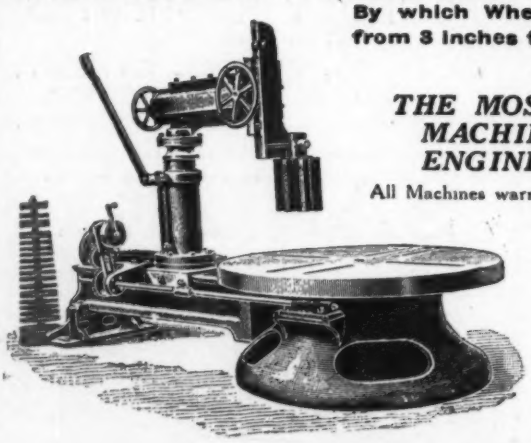

38¼
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL, LTD.
KINNING PARK IRONWORKS,
GLASGOW
36"
32½"

CAN ALSO BE MADE IN ALUMINIUM.

Kindly mention this paper when enquiring or ordering

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made,



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

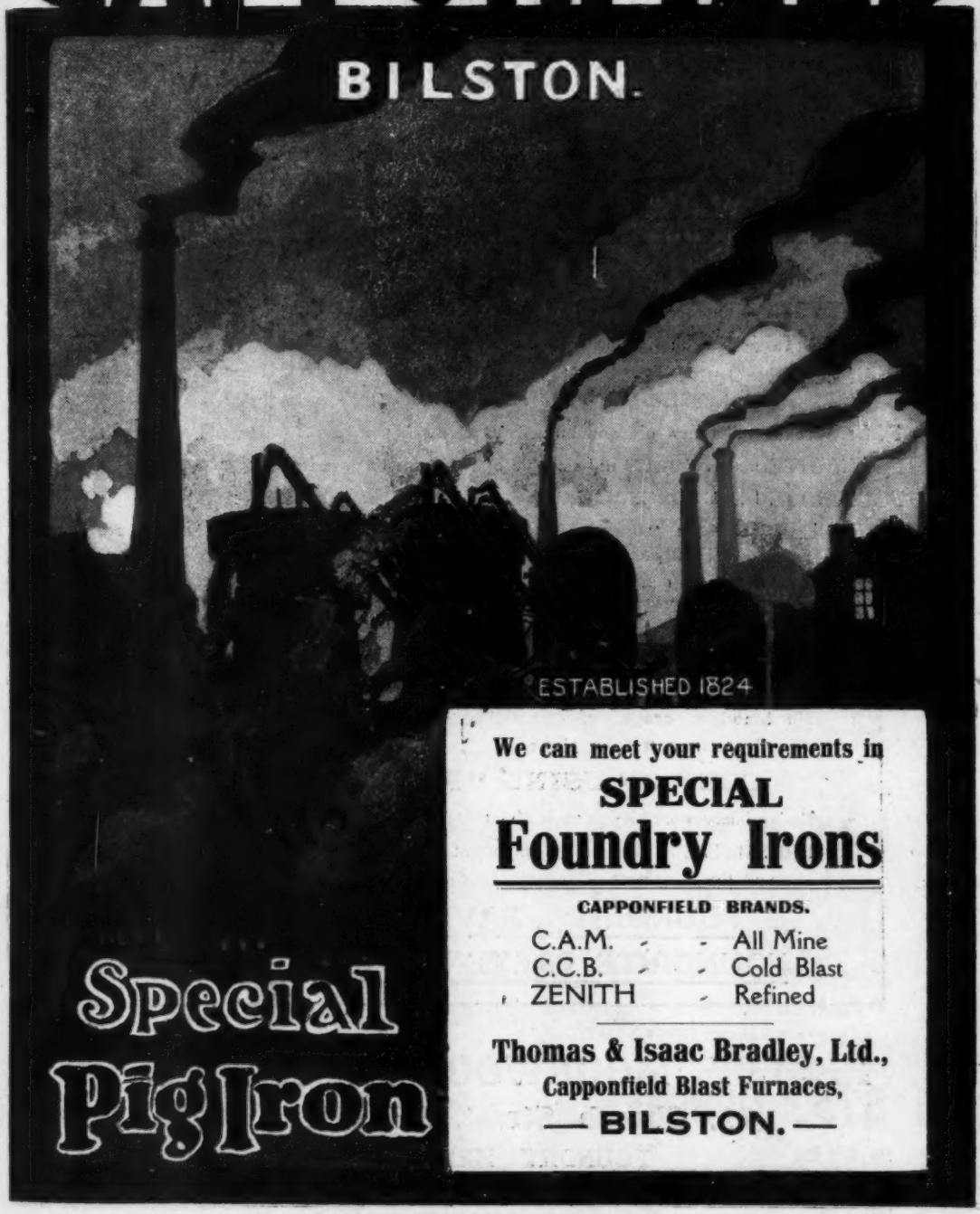
ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, OLDHAM.

CAPPONFIELD

BILSTON.



Special Pig Iron

We can meet your requirements in

SPECIAL

Foundry Irons

CAPPONFIELD BRANDS.

C.A.M.	All Mine
C.C.B.	Cold Blast
ZENITH	Refined

Thomas & Isaac Bradley, Ltd.,
Capponfield Blast Furnaces,
— BILSTON. —

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE is another German speciality superseded and improved.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over again.

FOUNDRITE makes **CORES** unbreakable and the use of **core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.
FOUNDRITE PREVENTS WASTERS.

Telegraphic Address—"MOROD, SHEFFIELD." **Telephone 4318.**

HEDLEY MOORWOOD & Co., Ltd.,
21, Church Street, SHEFFIELD.
FOUNDRY EXPERTS.

T. & I. BRADLEY & SONS, LTD.,

DARLASTON, South Staffs.

SPECIAL COLD BLAST PIG IRONS.

Brands:

R.A.M. FOR CYLINDERS.

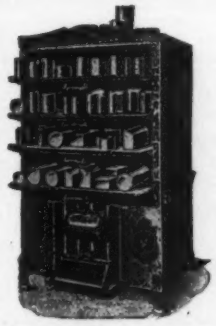
IXL. C.B.R. FOR CHILLED CASTINGS, &c.

D.M.R. CHARCOAL FOR MALLEABLE CASTINGS, &c.

✠ SELECTION ✠ ANALYSIS ✠ FRACTURE AND CHILL ✠ GUARANTEED ✠

ALL MINE.	WARM BLAST.	COLD BLAST.
◆ A M ◆	I X L.	I X L.-CB.

☛ IF YOU HAVE DIFFICULTIES WITH YOUR SPECIAL CASTINGS CONSULT US.
We can put you right.



THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it,

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers: **C. PORTWAY & SON,** TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, **HALSTEAD, ESSEX.**

H. J. EVANS & CO.

Telegrams: "GUNMETAL." Telephone: BANK 3842.

25, Lord St., LIVERPOOL.

METALLURGISTS' MANUFACTURERS, and MINE OWNERS.

Speciality: FERRO-SILICON, ALL GRADES. FUEL OIL FOR DIESEL ENGINES.

The following is a list of some of our lines, prices below competitors'. It will pay you to send us your enquiries:—

FERRO-ALLOYS, MINERALS, METALS & CHEMICALS,
RADIUM-BROMIDE, FERRO-CHROME,
FERRO-SILICON, FERRO-VANADIUM,
FERRO TUNGSTEN, FERRO-MANGANESE, FERRO-MOLYBDENUM, FERRO-TITANIUM,

ALUMINIUM, CADMIUM, CARBONATE OF POTASH, SILICA, REFINED SULPHUR,
FRENCH CHALK, ASBESTOS POWDER.
PLUMBAGO, GRAPHITE,
MANGANESE, LEAD ORE, FELSPAR,

CALCINED MAGNESITE AND MAGNESITE BRICKS,
FLUORSPAR, BOG ORE, BAUXITE, CHROME ORE, IRON ORE,
SPENTOXIDE AND RETORT CARBON,
OXIDES OF IRON, &c.

CONTRACTORS to BRITISH and ALLIED GOVERNMENTS.

THE CONSTRUCTIONAL ENGINEERING CO.,

(Proprietors: STEEL WORKERS. LTD.)

Telegrams: "Structural, B'ham. Telephone: Midland 2182.

From Photo of No. 4 Cupola complete with Tank-form Spark Arrester. Made in all sizes from 4 ton melting capacity to 15 tons per hour.

Manufacturers of every description of Foundry Plant.

Largest Makers of CUPOLAS in the Midlands.

IMPROVED
Rapid-melting
Full-economising
CUPOLAS.

FOUNDRY LADLES
from 28 lbs. capacity
to 10 tons ,,
A large number usually in stock.

EMERGENCY CUPOLETTES.

Also Makers of
Charging Platforms,
Shaking Barrels,
Hoists, Cranes,
Runways, etc.

TITAN WORKS,
CHARLES HENRY STREET. BIRMINGHAM.

PLUMBAGO. GLUTRIN.

Parting Powder. Wax Core Vent.

WILLIAM OLSEN, LTD.,
Cogan Street, HULL.

FOUNDRY MATERIALS AND REQUISITES.

WIRE BRUSH MANUFACTURERS.
STRAW ROPES.

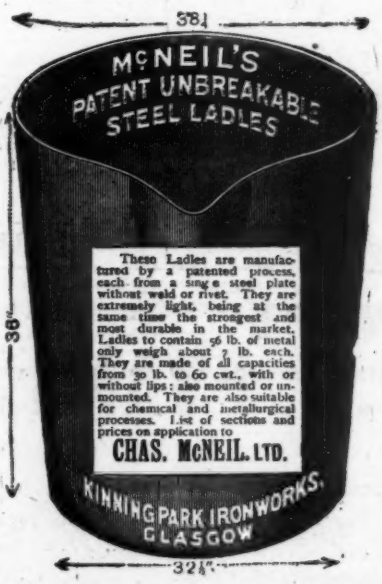
CORE OIL. CORE GUM.

FIRE BRICKS & CLAY

CUPOLA BRICKS.
Best Quality.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,
(STOURBRIDGE) Ltd.,
STOURBRIDGE.


38½
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL, LTD.
KINNING PARK IRONWORKS,
GLASGOW
36
32½

CAN ALSO BE MADE IN ALUMINIUM.

Kindly mention this paper when enquiring or ordering

JOHN HALL & CO.

OF STOURBRIDGE, LIMITED.

STOURBRIDGE, ENGLAND.

Manufacturers of

FIRE BRICKS, BLAST FURNACE BRICKS AND CUPOLA BRICKS.

CUPOLA BRICKS

FOR LINING ORDINARY AND PATENT CUPOLA FURNACES.

JOHN R. FYFE & CO.,

SHIPLEY, Yorks.

FERRO-VANADIUM. * * * * * FERRO-TITANIUM.

SILICO-MANGANESE { 23/30 % Silicon. 65/70 % Manganese and 1 %, 2 %, 3 %, Carbon Maximum.

FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.

FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.

ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*

WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.

EVERITT & CO., 40 CHAPEL ST., LIVERPOOL.

Telegrams: "PERSISTENT." Telephone No. 1134 (2 lines).

AS SUPPLIED TO H.M. WAR OFFICE.

THE ORIGINAL AND BEST CORE COMPOUND.

"SPERMOLIN"

(Registered Trade Mark.)

For particulars apply to the Makers :—

THE SPERMOLIN CORE CO.,

George Square,

HALIFAX.

Telegrams :—"SPERMOLIN, HALIFAX." *Telephone :—397 Halifax.*

A. J. WAKELIN, LIMITED.

FOUNDERS

ALUMINIUM

Telephone: No. 863 Sydenham.

BRASS, GUN METAL, PHOSPHOR BRONZE, | WHITE METAL, BELL METAL.

AERO AND MAGNETO CASTINGS.

BECKENHAM METAL WORKS, RAVENSCROFT ROAD, BECKENHAM, KENT

(KENT HOUSE STATION).

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

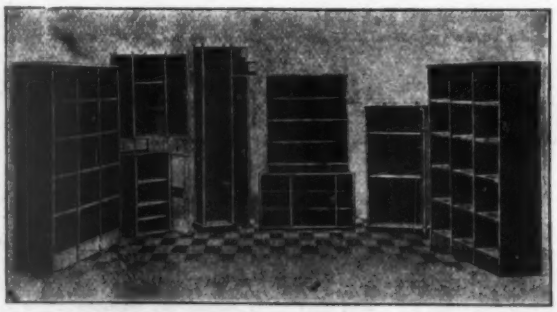
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."



GIBBONS

Steel Shelving, Lockers, Bins, Cupboards, Etc.,

FOR

WORKS, OFFICES, BANKS, AND WAREHOUSES.

JAMES GIBBONS,

St. John's Works, WOLVERHAMPTON.

London Office: Fisher St., Southampton Row.

WE SUPPLY THE LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

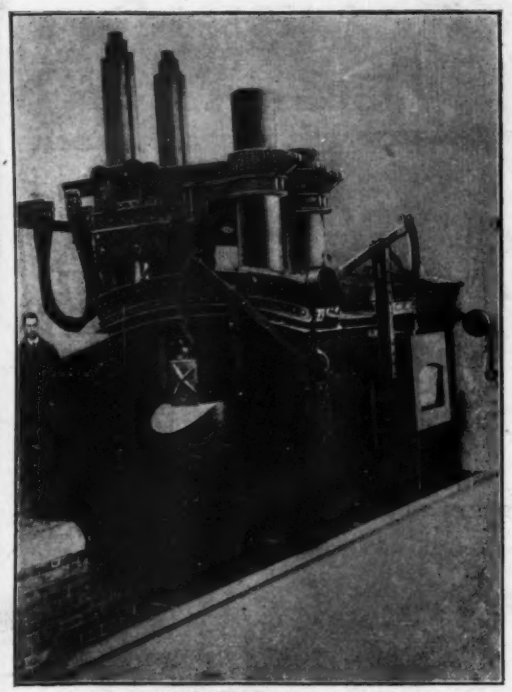
OF ALL KINDS

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.



3-Ton GREAVES-ETCHELLS Electric Furnace.

FOR

STEEL CASTINGS

The Electric Furnace clearly leads—phosphorous and sulphur can be removed far more completely than by any other process. At the same time, the gases which molten steel generally holds in solution are largely eliminated, and a steel is produced of exceptionally high purity. The ease with which electric furnace steel, containing low carbon and only small amounts of silicon and manganese, can be poured into small and intricate castings, flowing smoothly like milk, setting perfectly quietly in the sink heads, and producing castings with hardly a trace of blow holes, even in the hands of comparatively inexperienced steel makers, is largely due to its great purity.

"GREAVES-ETCHELLS"

ELECTRIC FURNACE

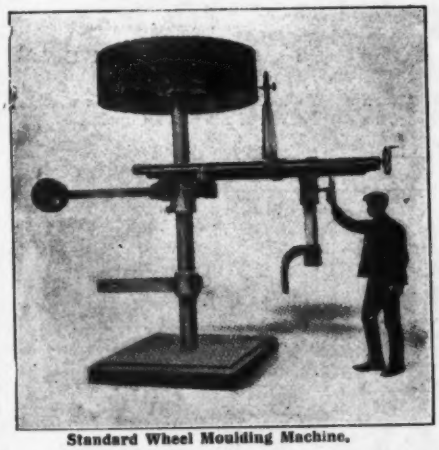
Used by many of leading Sheffield Steel Makers.

Sizes—10 cwts. to 12½ tons.

T. H. WATSON & Co. (OF SHEFFIELD), LTD.,

Telephones—1652, 1653, 1310
Telegrams—"CARGO, SHEFFIELD."

LANCASTER STREET,
SHEFFIELD.



Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

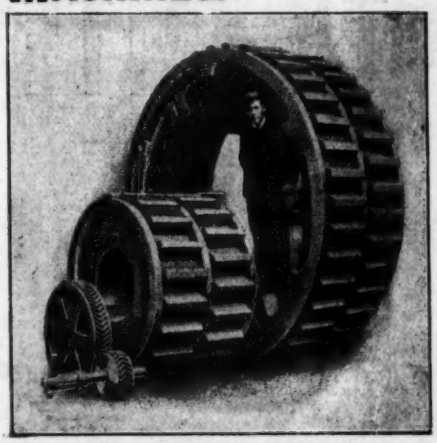
No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.,

LONDON ROAD IRONWORKS, GLASGOW.



Wheels Moulded by this Machine.

FOUNDRY PLANT.

"Rapid" Cupolas,

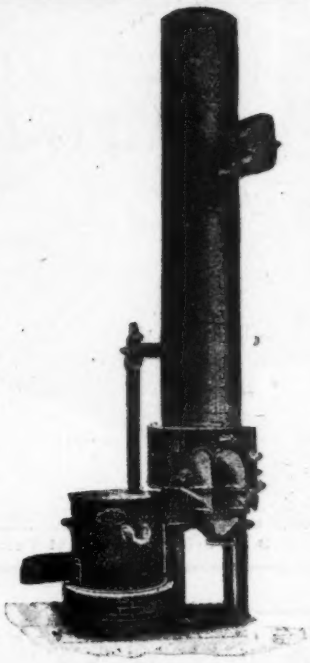
with or without receivers or drop bottoms.

Roots' Blowers,

belt, steam-engine, or electro-motor driven.

Charging Platforms,

Hoists, and Ladles.



ECONOMICAL RESULTS GUARANTEED.

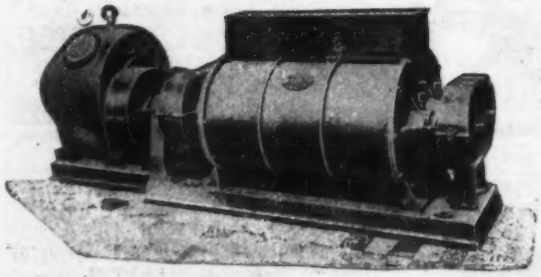
We are also Manufacturers of Steam Hammers, Smiths' Hearths, Centrifugal Pumps and Fans, High-Speed Engines and the "Bradford" Patent Boiler Feed Pump.

We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

CONTRACTORS TO HIS MAJESTY'S GOVERNMENT.

THWAITES BROS., LTD.,

Vulcan Ironworks, BRADFORD.



Telegrams—
"THWAITES, BRADFORD."

Telephone—
Nos. 3459 and 3460 BRADFORD.

London Office:
98 & 98, Leadenhall Street, E.C.

Catalogues on Application.

ANGLO-MEXICAN PETROLEUM COMPANY, LTD.

Exporters and Marketers
of the products of the
Mexican Eagle Oil Co., Ltd.

Head Office:
FINSBURY COURT, FINSBURY PAVEMENT,
LONDON, E.C.2.

Telephone: 2704 City.

Telegrams: "Mexprodux, Ave, London."

Branch Offices:

NEW YORK: 65, Broadway.

RIO DE JANEIRO: Avenida Rio Branco, 41.

BUENOS AIRES: Reconquista, 46.

A NEW STEEL BARROW

(PATENTED).

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is 25 per cent. greater than the ordinary style, yet it can be wheeled with half the labour, and can be emptied much more quickly. It is a perfectly balanced barrow, and a full load can be easily wheeled by a boy.

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS and PLATES up to 15 FEET LONG.
RANGE OF GAUGES 8 to 30 W.G.
RANGE OF WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, BOGIES, TRUCKS, GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and PUTTYLESS ROOFLIGHTS.

BRABY for galvanised corrugated **STEEL**
SHEETS: "EMPRESS" and "SUN" BRANDS.

FREDERICK BRABY & Co., Ltd., Eclipse Iron and Galvanising Works and Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast, and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS.

Telegrams—"Braby, Glasgow."

COMPLETE PATTERN SHOP PLANT

Which will pay for itself in six months.

LESS COST, LESS POWER, LESS ROOM—AND BETTER RESULTS.

1265 Universal Wood Workers in actual operation.

500 of this number built and sold in one year.

Made in 7 different sizes and for any particular purpose.

COMPLETE LINE OF WOOD WORKING MACHINERY KEPT IN STOCK FOR IMMEDIATE DELIVERY.

The Famous Universal Wood Worker.

Our Famous Universal Wood Worker, when equipped with all possible attachments, stands complete as a band saw, jointer, saw table, single spindle shaper, two-spindle borer, mortiser, tenoner, rim borer, felloe rounder, wheel equaliser, disc sander, drum sander, panel raiser and knife grinder.

Sole British, Colonial and Foreign Selling Agents

UNIVERSAL MACHINERY CORPN. LTD., 326, OLD STREET, SHOREDITCH, **LONDON, E.C.**

WILLIAM CUMMING & CO., LTD.,

IRONFOUNDERS FURNISHERS

Established 1840.

FOR
IRONFOUNDERS'
BLACKING
PLUMBAGO
BLACK LEAD
CORE GUM
COAL DUST
ETC.

—o—

Write for Quotations.

WORKS—
Kelvinvale Mills, Maryhill, Glasgow.
Sunnyside Blacking Mills, Falkirk.
Old Packet Wharf, Middlesbrough.
Albion, West Bromwich.
Whittington Bracking Mills, Nr. Chesterfield.

Also
THE WELL-KNOWN BRANDS
"IMPERIAL"
"EUREKA"
"VULCAN"
"CROWN"

Registered Brand—
"SHALACO"

Telegraphic Address—
Prudence, Glasgow.
Cummin, Blacking Mills, Camelon.
Cumming, Whittington, Chesterfield.

THOS. BROADBENT & SONS, Ltd.

CENTRAL IRONWORKS, HUDDERSFIELD.

TRY A

BROADBENT CRANE

IN YOUR FOUNDRY

AND SAVE

TIME, LABOUR AND EXPENSE.

Tels: Broadbent, Huddersfield.
Tele: 1581 (4 lines).

London Office, Suffolk House,
Laurence Pountney Hill, E.C.

ANALYSES

MECHANICAL TESTS
and MICROGRAPHS

Consulting Metallurgists and Analytical Chemists.

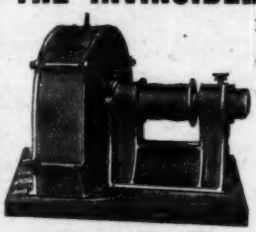
— SPECIALISTS —
IN FOUNDRY WORK.

Laboratory for all kinds of Metallurgical Investigations.

NAISH & CROFT,

150, Alma Street, BIRMINGHAM. | 24, University Mansions Putney, LONDON, S.W

THE INVINCIBLE SAND MIXER.



18" *Mixer*— 1 *Ton per Hour.*

Fitted with Patent Roller Bearings, Renewable Reels, Grinds, Mixes, Screens & Prepares.

OLD AND NEW FOUNDRY SANDS AT LOWEST COST.

Saves Labour—Reduces Foundry Costs.

Made in Three Sizes—1, 3 and 6 Tons per hour capacity.

USED IN PRINCIPAL FOUNDRIES.

PRICES ON APPLICATION.

C. E. V. HALL, 26, Paradise Sq., Sheffield.

IRON AND STEEL FOUNDRY REQUISITES.

Blackings, Plumbago,
Black Lead, Chaplets,
Nails and Sprigs, Core Gum, &c.

Agents for "GLUTRIN" Core Binder.

THOMAS WILKINSON & CO., LTD.,

Manufacturers and Merchants, MIDDLESBROUGH.

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER

Telephone: "No 2297 CENTRAL" MANCHESTER.

JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.